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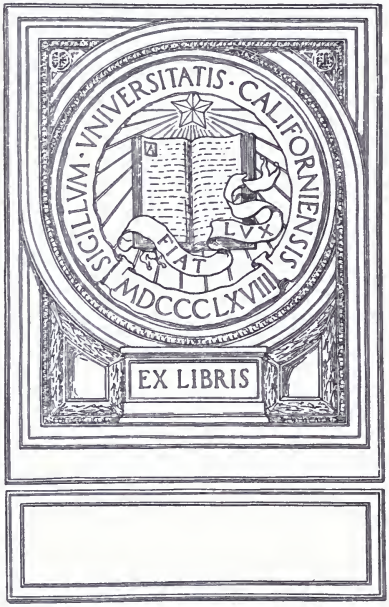

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THE CALIFORNIA SPECIES OF MEALY BUGS

BY
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INTRODUCTION

PURPOSE AND SCOPE OF THE PAPER

The systematic literature dealing with certain groups of the Coccidae or scale insects is extremely unsatisfactory, this condition being especially pronounced in the case of those groups commonly called the "soft scales." The present author (4)† has stated in an earlier paper that ". . . of the nearly 100 species of mealy bugs thus far described from North America, including some 35 from California, not more than three or four are recognizable at all on the basis of the published descriptions if taken apart from their typical host and their type locality," nor at the time of the present writing does this statement need any extensive modification. A few species have been described since the statement was originally made and to some of these it may not apply, but so far as the species known at that time are concerned, the additional claim may safely be made that even under the optimum conditions cited, the identification of many of our species can not be accomplished with reasonable certainty.

The actuating motive of the present paper has been the hope of remedying this condition as far as may be for those species of mealy bugs occurring in California. However, progress toward this goal has been made possible only by the utilization of certain methods not ordinarily employed, at least by American entomologists, and by the emphasizing of certain morphological features of which some have been entirely overlooked and of which the full significance of none seems at any time to have been realized. The scope of the paper has therefore been extended to include an explanation of these methods and a description of these morphological features.

The restriction of the paper to those species occurring in California has not been due to any desire to keep within the boundaries of some artificially defined political unit nor to any belief that the California mealy-bug fauna is at all separable as a group from that of the rest of North America. The limitations imposed have been purely those of convenience. It so happens that most of the species known from west of Colorado and New Mexico have been described from California and that the types of these are for the most part in western collections. It also happens that most of the California species have been taken from two

†Numbers in the text refer to the list of references cited at the end of the paper.

rather restricted localities, thus making it a comparatively simple matter to procure topotypic material.

While it has therefore been convenient to treat of the California species as a separate group, the disadvantages of so doing have been fully realized. The range of most of our species is by no means so restricted as would appear from the published records and it is highly probable that at least a part of the species herein recorded as known only from California occur in the eastern states as well. In fact it is definitely established that at least three species have been described under different names from California and from the eastern or central states and it is almost certain that the same thing is true of some others. For the sake of stability in nomenclature it is highly desirable that the mealy-bug fauna of the entire continent be treated as a unit, but it has not seemed wise to wait until this can be done. A beginning must be made some place.

ACKNOWLEDGMENTS AND MATERIAL

Acknowledgments are due first of all to Mr. E. O. Essig of the University of California, who has most kindly placed his entire collection, including types, at my disposal with the fullest permission to remount any of the specimens as I saw fit. Without this assistance it would literally have been impossible to proceed. Scarcely less am I indebted to Mr. E. M. Ehrhorn of Honolulu, who has made numerous comparisons of specimens with types in his collection and who has lent material of critical importance. Mr. C. P. Claussen, of the California State Board of Horticulture, has also lent types of manuscript species in his collection and has assisted in procuring other material. Mr. A. F. Swain of the Citrus Experiment Station at Riverside, Mr. S. P. McClenahan of Palo Alto and Professor R. W. Doane of Stanford University have aided in the procuring of several species which could not otherwise have been obtained. Mr. Harold Morrison of the Bureau of Entomology has rendered invaluable aid by comparing specimens with types in the National Collection of Coccidae at Washington and by notes which he has generously furnished. Mr. E. E. Green has supplied me with material of several genera and species having a bearing upon the general problems connected with this group. To all these gentlemen are due the fullest thanks for their assistance.

With the material obtained from the above sources, together with that in the Stanford collection when I began work and with that procured by my own efforts, I have been enabled to examine types, topotypes or other authentic material of nearly all the species recorded from the state. Two species have escaped me entirely, and of a few I have not been able

to see authentic material, although I believe I have satisfactorily identified them. Two species which have been recorded from the state, but which were certainly introduced and are not now known to occur here, have been passed over with a mere mention.

TYPES

The types of all the new species herein described are in the Stanford collection. In all cases a holotype has been selected. It is perhaps not out of place to urge that this method be adopted by all students of the Coccidae, for even in this limited study three cases have been met with in which more than one species had been included in material labeled type. There is really no more reason for failure to name holotypes in this group than in any other.

METHODS OF STUDY

The satisfactory study of any of the scale insects demands the use of special methods in the preparation of specimens for microscopic examination and such methods are especially useful in the group here under consideration. I feel no hesitation in saying that by far the greater part of the difficulty that has been experienced in dealing with this group has been due solely to the unsatisfactory methods usually employed in the making of microscopic mounts. Satsifactory work can not possibly be done on the basis of tangled masses of antennae, legs and spines, or of specimens so transparent that they can scarcely be located on the slide. Yet it is exactly upon such preparations as these that most of the systematic work on this group has been based. The possession of first-class preparations is as essential for the proper study of these insects as is the possession of a microscope.

In the past, the difficulty has been due for the most part to the lack of satisfactory methods by which good preparations may be obtained and to some extent to the failure to use those methods which were available. Within recent years the problem has been attacked by various investigators and there no longer exists any excuse for the employment of the crude and unsatisfactory methods with which authors, until very recently, have been content. Green (5), Brain (2), Stafford (10), and Dietz and Morrison (3) have all recommended methods, the simplest and least cumbersome of which is perhaps that described by Stafford. This, with certain modifications, is the one which I have employed.

The general method is simple enough. Specimens may be preserved either dry or in alcohol, preferably the latter, as it is sometimes quite difficult to straighten out individuals which have become wrinkled in drying. The loss of the secretionary covering in the alcohol is a minor point, for the final determination of species cannot be made from this covering and it is usually of incidental assistance only. To prepare the specimens for study they should be boiled in a *weak* solution of caustic potash. This, for reasons which I shall later explain, should not be more than about an 8% solution. The boiling should be carried merely to the point where the body contents are thoroughly disintegrated, this point usually being reached before the color has been entirely lost. The specimens should then be removed to clean water in a watchglass under a binocular microscope (one of the most indispensable aids in procuring first-class preparations), a slit cut in one side of the body and the body contents pressed

out through this opening. For this purpose a straight needle and one with the tip bent at right angles to the shank are most useful. Upon the care with which this operation is performed, including the careful flattening out of the body in the most favorable position for study, will depend much of the value of the mount. It should be remembered that the body contents will take the stain and if not thoroughly removed will more or less obscure the characters that it is necessary to see.

Trouble is frequently experienced at this point due to the formation of hard, white lumps either within the body or partially encasing it. Apparently these lumps are formed by the combination of the caustic potash with the body fats and there seems to be no way by which their formation can be prevented. However, they are readily soluble in carbol-xylene and may be removed by placing the specimens in a small amount of 95% alcohol containing a few drops of this reagent. This should not be done, however, until the specimens have been cleaned as thoroughly as possible, as the alcohol hardens the body contents and makes them difficult to remove. The carbol-xylene should be washed out in 95% alcohol before the specimens are placed in the stain. If difficulty is not experienced with the formation of such lumps the specimens may be removed to the stain directly from the water in which they are washed.

The stain which I have used is Magenta and I cannot speak in regard to the action of any of the others that have at times been recommended. This stain may be procured in liquid form. The strength of the solutions obtained seems to vary somewhat, but there appears to be very little, if any, difference in their staining qualities and they can sometimes be much diluted with water. Staining is best carried on in deep hollow slides having a ground-glass surface upon which data may be written. These should be covered with a coverglass and the stain allowed to run out under this. The evaporation of this stain under the coverglass will seal a slide so effectively that it may sometimes remain for days without drying out.

Usually a half hour is sufficient to give a stain as good as can be obtained, this having been demonstrated by numerous experiments. The specimens should then be removed to 95% alcohol in which the excess stain is washed out, then placed for a moment in carbol-xylene (three parts xylene to one part carbolic-acid crystals) and then mounted in balsam. If the staining has been effective the resulting mount should show all spines and chitinized areas of a bright red, while the remainder of the derm is perfectly clear.

As I have said, the general method is simple enough, but care in numerous details which one can only learn from experience is necessary to get the best results. Above all care must be taken that the specimens

do not become unduly heated, as this destroys their staining qualities, the resulting preparation being of a uniform bluish color and showing little or no differentiation between the various parts. It is for this reason that a weak solution of caustic potash should be used, for it appears that the boiling point of a strong, "soupy" solution is somewhat higher than the critical point.

It is especially noteworthy that the method outlined above may be used for the purpose of rendering old mounts suitable for study. The results obtained are sometimes not as good as with fresh material, but they are usually very much worth while. The specimens should be removed from the mount if possible without the use of heat, or if heat is necessary, it should be very carefully applied. The specimens should then be freed from the medium in which they have been mounted, the method of doing so depending upon what medium has been used. If the medium is balsam they should be soaked in carbol-xylene or a similar reagent, if glycerine jelly they may be boiled in caustic potash. In any case this boiling should not be omitted, as it renders the specimens flexible. Following this the treatment proceeds in the usual manner. The only risk encountered in attempting to stain old mounts lies in the possibility that they may have been overheated when they were originally made and this can only be discovered by experiment. However, this risk may partially be avoided by staining but a part of the specimens contained in the mount.

TAXONOMIC VALUE OF MORPHOLOGICAL CHARACTERS, SECRETIONS, AND BIOLOGY

MORPHOLOGY

The morphology of the mealy bugs has been dealt with to some extent by Berlese (1) who has described some of the structures that are available for taxonomic purposes, although he has not himself carried out any taxonomic studies; Marchal (7) seems to have been the first to make use of these characters. Smith (9a) has investigated the value of the characters ordinarily employed and in a later paper (9b) has discussed the possible value of others. Brain (2) has also pointed out the possible value of many characters not ordinarily employed, although, curiously enough, he does not himself make any particular use of these characters. In no case does there seem to have been any real appreciation of the full value of the characters observed and there still remain some that do not appear to have been noted at all.

In view of the fact that no wholly satisfactory discussion of the taxonomic value of the various morphological features of this group exists it is necessary to consider the matter at some length. Unfortunately the material available for study is somewhat limited and most of the conclusions presented must be regarded as but tentative. However, they apply to the material examined by me (which includes a number of species not coming within the scope of this paper), and very probably apply to a considerable degree to the remainder of the group.

Adult Female

Antennae.—Almost since the serious study of the Coccidae began the antennae have been relied upon to furnish both generic and specific criteria. The present generic concepts in the group here under consideration are based in large part upon the number of segments in the antennae of the adult female and the relative or actual lengths of the individual segments have been much used for purposes of specific differentiation. The value of the antennae in defining generic groups will be discussed in a later paragraph on generic concepts and we shall here consider merely their value as specific criteria.

If we compare a limited number of individuals of a few species it may not only appear that there are certain rather obvious differences in the actual lengths of the individual segments and of the antennae as a whole, but there may also be differences in the relative lengths of the

segments, differences which are somewhat difficult to express. Attempts to present these differences in a tangible way have led to the introduction of the familiar "antennal formulae" and the more recent "antennal graphs." The weakness of the antennal formulae is now fully realized and they are at present but little used, yet their pernicious effects remain, for few, if any, of the species established largely upon them have ever been redescribed and many of these must stand in our literature as doubtfully recognizable, or even not recognizable at all, until their types have been re-examined. I cannot but consider the original introduction of these antennal formulae as the most unfortunate mistake that has been made in the study of the Coccidae.

The antennal graphs have been but recently introduced and have not received any extensive trial. It will therefore be desirable to consider them at some length. It may be said in their favor that if the antennae are at all to be used as specific criteria no better method than this can be devised by which to present the facts. The weakness of the method will be in large part due to the unsatisfactory character of the material with which it must deal. It can at the best do nothing more than transfer difficulties from the slide to the paper before us where they may perhaps be analyzed.

The method of constructing these graphs is quite simple. The actual measurements of the individual segments are obtained by the use of an ocular micrometer. Then upon a sheet of co-ordinate paper certain units are laid out along one axis to represent the individual segments and upon the other axis are plotted the lengths. Connecting up the points thus obtained we have a graph which will give a very clear indication of the relative and actual lengths of the segments. Plotting the graphs of several antennae will indicate the range of variation. The method of constructing these graphs has been discussed at length by Brain (2) and Hollinger (6) and for the purpose of this paper a combination of the methods used by both of these authors has been employed.

In order that these graphs may be of value for taxonomic purposes it must be shown that the graphs of different species are sufficiently different and sufficiently constant to permit of differentiation between the species. Brain and Hollinger have considered that this condition is met, the former having relied very heavily upon these graphs and the latter having stated that with him the graphs "formed the working basis" for specific indentification.

I may say without reserve that I consider these graphs to be fully as illusory and fully as dangerous as were the now wholly discredited antennal formulae.

The objections to these graphs are both general and specific.

The graphic method is essentially a method of averages. Even though it be true that the average graph of any species is relatively constant this does not aid in the identification of non-average individuals. We must deal with individuals and not with averages.

The graphs are neither sufficiently distinctive nor sufficiently constant to be of value in separating species. In those cases where two or more species occur together on the same hosts the graphs will not, in general, reveal the fact that more than one species are present.

The range of observed variation in those species which have been sufficiently studied is so great as to preclude the use of the graphs.

In proof of these contentions I shall present certain specific instances.

The two species, *Pseudococcus crawii* (Coq.) and *P. quercicolus* n. sp. occur in the vicinity of Stanford University upon the same hosts and have at times been found together. In life they are so very similar that they are scarcely distinguishable, but structurally they are very different, as a reference to the figures illustrating the two will show. Text figures 1 and 2 present the graphs of these two species. These

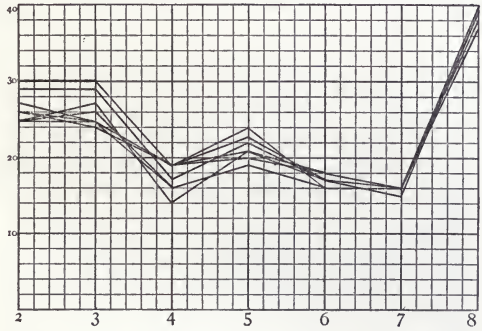

Fig. 1.—*Pseudococcus crawii* (*Coq.*); antennal graph drawn from specimens taken from *Quercus chrysolepis* in the vicinity of Stanford University.

graphs were obtained from individuals taken from the same host plants in the same vicinity. The two graphs coincide practically throughout and it is obvious that no amount of contemplation of a graph, including both species, would reveal the fact that two species are present.

Again, let us consider the case of *Pseudococcus ryani* (Coq.) and *P. sequoiae* (Coleman). These two species occur together on *Sequoia sempervirens* in the vicinity of Stanford University and both have been recorded from various species of *Cupressus*. The two species are suf-

ficiently different in life to indicate that they are distinct and structurally, while very similar, are sufficiently well marked to be readily separable in

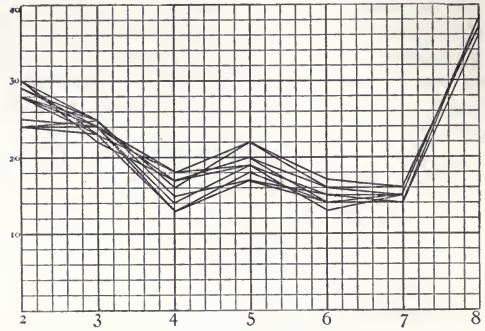

Fig. 2.—*Pseudococcus quercicolus* n. sp.; antennal graph drawn from specimens taken from *Quercus chrysolepis* and *Pasania densiflora* in the vicinity of Stanford University.

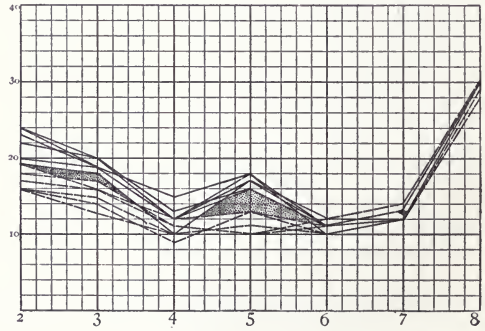

Fig. 3.—*Pseudococcus ryani* (*Coq.*) and *P. sequoiae* (*Coleman*); antennal graphs drawn from specimens taken from *Sequoia* in the vicinity of Stanford University; graphs of *ryani* drawn in solid lines, those of *sequoiae* in broken lines; shaded area indicates the gap between the two.

good preparations. Text figure 3 represents the graphs of the two species obtained from individuals taken from *Sequoia* in the same locality. It will be noted that the two graphs are in part quite distinct and that there is an evident tendency for the average of one to lie well below the

average of the other. Still it is fair to ask to what extent these graphs would be of aid did we not already know the two species to be distinct.

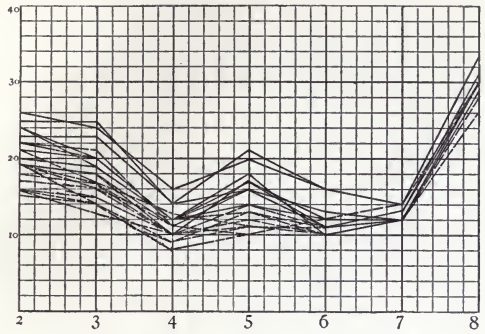

Fig. 4.—*Pseudococcus ryani* (*Coq.*) and *P. sequoiae* (*Coleman*); antennal graphs drawn from specimens taken from various hosts and localities; position of graphs as in fig. 3.

Text figure 4 presents the graph obtained by using all the available specimens of these two species from different hosts and localities. It will be noted that the gap between the two graphs has entirely disappeared, although the average graphs would still lie quite far apart. Again it is fair to ask if anyone would separate these species on the basis of such a

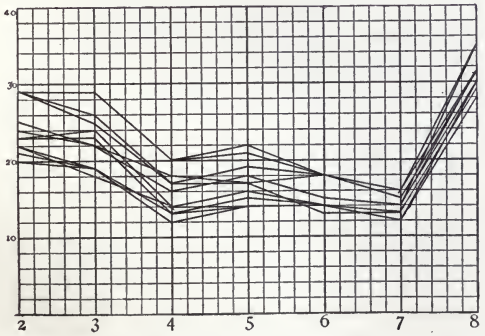

Fig. 5.—*Pseudococcus longispinus* (Targ.); antennal graph drawn from specimens taken from various hosts and localities.

graph did he not already know them to be distinct, or, knowing them to be distinct, where he would draw the line between them.

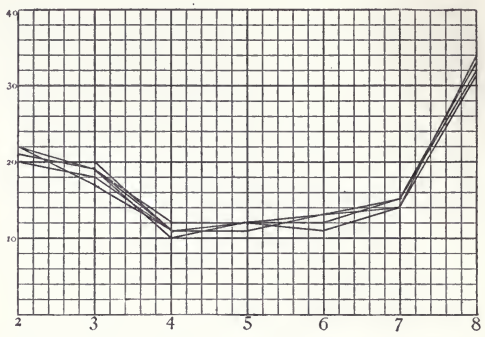

Fig. 6.—*Pseudococcus citri* (Risso); antennal graph drawn from specimens taken from citrus.

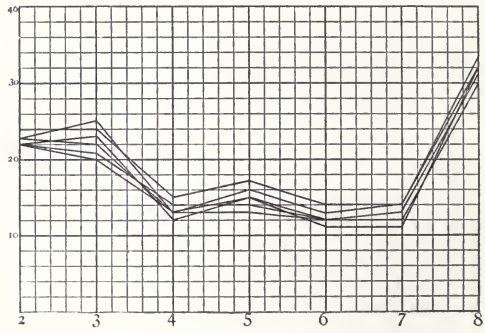

Fig. 7.—*Pseudococcus citrophilus* Claussen; antennal graphs drawn from specimens taken from citrus and other hosts.

In text figures 5 to 8 are shown the graphs of the four species, *Pseudococcus longispinus* (Targ.), *P. citri* (Risso), *P. citrophilus* (Claussen) and *P. maritimus* (Ehrhorn). All four of these species occur on citrus, as well as on many other hosts, in California. They are readily separable in life and structurally are very different and very easily recognizable. Yet the graphs of the first three fall almost entirely within the graph of *P. maritimus* nor is there sufficient difference between any of

them to "form a working basis" for their separation. It may be pointed out that the use of more individuals would in all probability have increased the difficulty in distinguishing between the graphs due to the introduction of extreme forms.

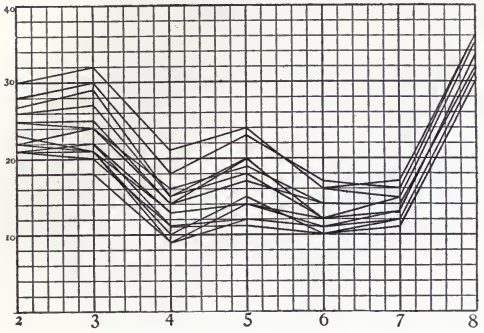

Fig. 8.—*Pseudococcus maritimus* (Ehrh.); antennal graphs drawn from specimens from various hosts and localities.

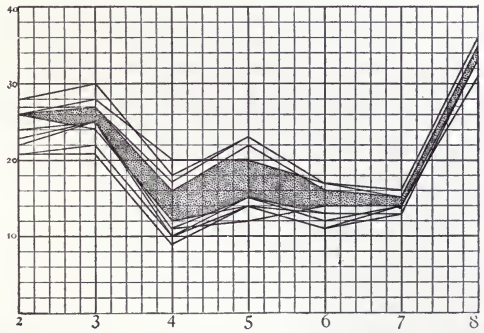

Fig. 9.—*Pseudococcus maritimus* (Ehrh.); antennal graphs of specimens taken from *Mesembryanthemum* at La Jolla (above) and *Rubus vitifolius* at Stanford University (below). The shaded area indicates the gap between the two.

In text figure 9 are shown the graphs obtained from specimens of *P. maritimus* taken from *Mesembryanthemum* at La Jolla, Calif., and from *Rubus vitifolius* at Stanford University. There is more difference

between these two lots of specimens belonging to the same species than there is between any of the species previously discussed. It may, of course, be asserted that we are here dealing with distinct species. It is true that structurally these individuals are slightly different but the differences are at the best small and are connected by a complete series of intergrades.

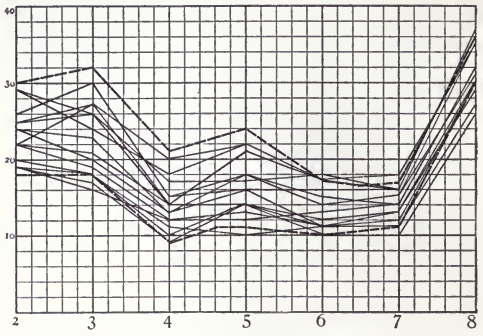

Fig. 10.—*Pseudococcus maritimus* (Ehrh.); graphs of observed extremes (indicated by heavy, broken line), including within them the graphs of individual antennae of 13 other species (indicated by solid lines).

In figure 10 the heavy, broken line indicates the observed extremes of *P. maritimus* and included wholly or in large part within these extremes are the graphs of individual antennae of thirteen other species, including such diverse forms as *Trionymus calceolariae, Pseudococcus citri, P. citrophilus, P. comstocki, P. crawii, P. krauhniae, P. longispinus, P. pini, P. quercicolus, P. ryani, P. salinus* and *P. virgatus.* On the basis of this graph any of these individuals might well be *P. maritimus.*

It seems hardly necessary to pursue the matter further. I have expended so much space in attempting to show the futility of these graphs, not because of any personal prejudice against the method, but from a belief that its use can do nothing but perpetuate the confusion now existing in the systematic literature of this group. The material with which the method deals is of such a nature as to preclude its use and there are other and fully reliable characters upon which determinations of species may be based.

Legs.—In many descriptions a considerable amount of attention has been paid to the legs, their actual measurements in microns being given

and the character of their vestiture of hairs being minutely dealt with. In general I have not found such characters to be of any special value.

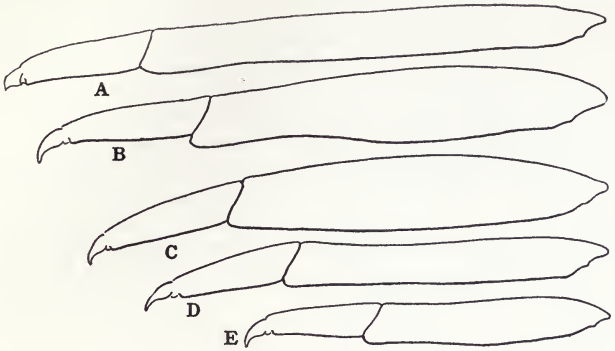

Fig. 11.—*Pseudococcus maritimus* (Ehrh.); outlines of legs, to show variation. A, from *Salix* at Stanford University; B, from passion flower at Palo Alto; C, from orange in southern California; D, from *Mesembryanthemum* at La Jolla; E, from roots of clover at Medford, Oregon.

In text figure 11 are shown some of the variations in size found in *P. maritimus*. Where extreme differences are found, such as in the case of *Erium lichtensioides* and *Ripersiella kelloggi* where the legs are much reduced in size, they may be of a certain value. Reference to the legs has been omitted in this paper except in such cases.

Fig. 12.—Tarsal claws of: A, typical *Phenacoccus,* and B, typical *Pseudococcus.*

The tarsal claw, however, affords certain very convenient generic characters. In certain groups there is a minute tooth or "denticle" on the face of the claw (figure 12) which affords a most valuable "key character." Taken by itself this character is probably of little importance, for it has certainly been independently developed in widely separated groups (for instance, it appears in some of the Margarodinae), but in conjunction with other characters it is extremely useful. I have not been convinced that the digitules merit special attention.

Mouthparts.—These seem to present no characters of taxonomic value.

Dorsal Ostioles.—Upon the dorsum of all the Pseudococcine forms examined by me there are to be found at least one pair of curious pits with raised, lip-like margins, the "eye-like glands" or "cicatrices" of various authors, the "fossette ostioloformi labiate" or "foveole labiate" of Berlese (1, p. 82, figs. 8, 10). It is probable that two pairs of these are always present, one pair being found just within and slightly behind the eyes, the other being on the third segment from the posterior end of the abdomen or between the second and third segments. The position of

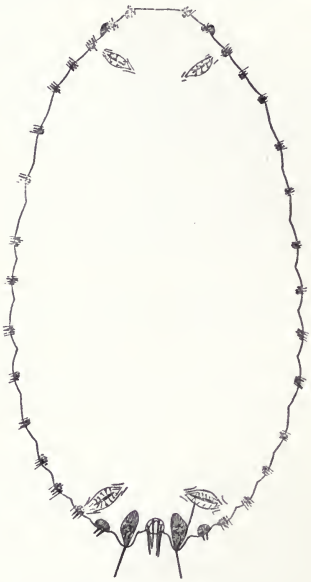

Fig. 13.—*Pseudococcus longispinus* (Targ.); outline of body to show position of dorsal ostioles.

these organs is shown in figure 13. To these I apply the name "dorsal ostioles," for they appear to correspond in function to the lateral ostioles of the Heteroptera. Berlese seems to have regarded these structures as points of attachment for muscles, but this interpretation is probably wrong. If an active mealy bug be disturbed it may aften be noticed that one or more globules of liquid appear upon the dorsum. The posi-

tion of these globules, at the most four in number, corresponds to the position of the dorsal ostioles and there seems to be no room for doubt that it is from these ostioles that they arise. Whether they are secretions from special glands or are of some other origin, I cannot at present say. The connection of these globules with the dorsal ostioles has been noted by Comstock in his Report of 1882.

In some cases the anterior pair of these ostioles appear to be much reduced in size and they are usually somewhat difficult to see, due to the fact that they lie directly above the anterior legs and are thus more or less obscured in preparations. For this reason I am not prepared to say that this pair is always present, but the posterior pair is to be found in all the Pseudococcine forms that I have seen. I have not been able to find them in the members of any other group and therefore regard them as perhaps the most distinctive character of the group here under consideration.

Cerarii.—This term seems first to have been used by Smith (9b, p. 74)† to designate the marginal groups of pores and differentiated spines (the "lateral patches of bristles" of some authors) from which arise the tassels or "filaments" of wax that are such striking features of many species of mealy bugs. While vague references to these structures have been made by various authors, Berlese (1, p. 81) seems to have been the first to describe them at any length, while Marchal (7) has been the first to realize their taxonomic value. Smith (9b), who seems not to have been familiar with Marchal's paper, has independently concluded that "the cerari as specific characters are very promising," and Brain (2) and Hollinger (6) have made some slight use of them.

These are to be regarded as structures of the very highest taxonomic value. They appear to be found only in the Pseudococcine group, although not all of the species belonging to this group possess them. This, together with the fact that they are sometimes so much modified as to render them scarcely recognizable, reduces their value as a group characteristic, but they still remain serviceable for generic and specific differentiation.

A typical cerarius consists of a pair of spines (herein spoken of as the "cerarian spines"), set close together at the margin of the body and usually accompanied by a more or less distinct group of triangular pores

†The derivation of this word is not explained by Smith and he has used the spelling "cerari" in both singular and plural. I am informed by Professor Elmore of the Department of Latin of Stanford University that the word appears to be incorrectly formed. He suggests that the spelling "cerarius" for the singular and "cerarii" for the plural be adopted, with "cerarian" for the adjective form. I have therefore used these forms throughout this paper.

and slender setae. This type, however, is subject to much modification. In some cases the cerarian spines are quite large and stout and are readily distinguishable from the body setae, while in others they are recognizable only by their paired character and position. In some cases the grouped pores are very numerous, in others entirely lacking. In some species the cerarian spines are accompanied by a group of slender setae, which I designate as *"auxiliary setae,"* while in others these are not present. In some more than two spines are present in part or even all of the cerarii.

In certain instances a part or even all of the cerarii are surrounded by more or less well defined chitinized areas which it is usually difficult or even impossible to see in unstained preparations. In the genus *Puto,* and in certain exotic species at present referred to *Phenacoccus,* all the cerarii are thus surrounded but in general these areas are to be found only in connection with the last one or more abdominal pairs. The size and shape of these areas are in some cases extremely constant and of much assistance in recognizing species. I am not aware that these have previously been noted except in connection with the genus *Puto.*

The number of pairs of cerarii ranges from none to as many as 24. Within certain limits the number may be taken as of generic value, although it is probably not always so. I have seen no species of *Phenacoccus* (except certain exotic forms now referred here, but which I am convinced are generically distinct) in which there are less than 18 pairs, and no species of *Pseudococcus* in which there are more than 17, although in some species there are less. In *Trionymus* the number is from one to four, while in *Antonina* there are none. While I have made use of these facts in this paper the matter needs to be much more fully investigated before any extensive generalizations can be made.

Anal Lobes.—The form of the anal lobes is in general not such as to be usable for taxonomic purposes, chiefly because of the difficulty experienced in obtaining preparations of a uniform type. In some cases they are quite prominent and in others practically lacking, but unless the characters displayed are of an extreme nature it is hardly possible to make use of them.

In certain species a more or less well defined chitinized area occurs on the ventral side of each anal lobe, usually extending in from the base of the anal lobe seta. In some species these areas are sufficiently constant in shape and size to be extremely useful characters, although in others where they are normally very small, they may vary even to the point of being entirely lacking and hence may not be relied upon.

Pores and Ducts.—No thorough investigation of the various wax-secreting glands of the Coccidae and of their ducts and pores has ever been made, yet it is probable that such an investigation would mark one of the most significant steps that can be taken in the study of this group. The existing information is very incomplete and in some instances quite misleading. It is not desirable to enter into any extended discussion of the subject here—it is deserving of a monograph by itself—but certain facts having a direct bearing upon the particular group under discussion may well be presented. Unfortunately there exists no satisfactory terminology for the various types of ducts and pores and a certain degree of circumlocution has been necessary in characterizing them, it being undesirable to propose a definite terminology until a comprehensive study of the whole subject has been made.

The wax-secreting glands are of several distinct types, each type discharging its products through the body wall by means of a different type of duct or pore. Certain of these types appear to be common to all the Coccidae, while others are apparently characteristic of particular groups. Their chief value will probably lie in the indications which they give of the relationships of the various genera, although at times they are useful even in the recognition of species.

The general type of gland opening through a duct (except in the Diaspinae) is shown in text figure 14, which represents a section through

Fig. 14.—Section through a wax gland of *Eriococcus adenostomae* Ehrh.

a gland of *Eriococcus adenostomae* (Ehrhorn). It will be observed that the duct is divided into two parts, a basal part of relatively large diameter, the inner end of which is reflexed to form a sort of cup from the rim of which rises the very delicate inner portion of the duct. Modifications of this type are found in the Coccinae and in certain groups of the Dactylopiinae (as this subfamily is understood in the Fernald Catalogue),

some of these modifications being shown in text figure 15. In all the Pseudococcine forms the inner end of the basal portion of the duct is truncate and never reflexed into a cup, a character which I consider to be distinctive of this group.

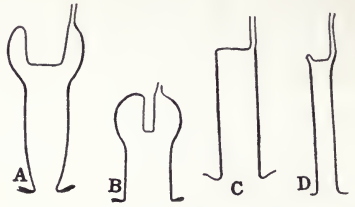

Fig. 15.—Diagrams of optical, longitudinal sections through ducts typical of: A, *Eriococcus;* B, *Kermes;* C, *Pseudococcus;* D, *Lecanium.*

These cylindrical ducts of the Pseudococcine forms present some features that may be used as specific criteria. Two rather distinct types are commonly to be found. In one of these the ducts are relatively large and the mouth is usually surrounded by a definite raised rim, while in the other the ducts are smaller and lack this rim. The relative numbers of these types is perhaps of specific importance, but is usually difficult to express and therefore chiefly of value in the direct comparison of specimens.

In some species the cylindrical ducts may be of a distinctive type, examples of this being seen in such species as *Phenacoccus stachyos, Phenacoccus kuwanae* and *Pseudococcus virgatus.* In *Phenacoccus stachyos* and *Pseudococcus virgatus* these ducts are strikingly large and in the first named species their mouths are borne at the apices of conical projections. In both of these species a conspicuous character of the living insect is the presence of numerous glassy, waxen threads, which undoubtedly originate from these ducts. In *Phenacoccus kuwanae* the cylindrical ducts are conspicuously short and stout.

The glands which do not possess cylindrical ducts discharge their secretions through various types of dermal pores. Certain of these types seem to appear in practically all of the Coccidae, while others seem to be confined to particular groups. The extent to which they may be relied upon in forming conclusions in regard to the limits of these various groups can not be discussed here, for only a very extended study could give such conclusions weight. However, they do appear to have certain values within the group here under discussion that may well be considered.

The dermal pores in this group are of three quite distinct types which are represented in text figure 16. Of these types, one (fig. 16a) is trilocular and more or less triangular in shape. Throughout this paper

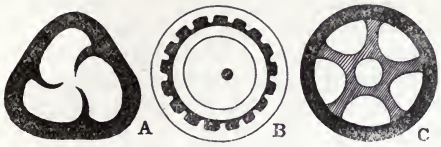

Fig. 16.—Dermal pores of Pseudococcine forms: A, triangular type; B, multilocular type; C, quinquelocular type.

it is spoken of as the "triangular type." Pores of this character are present in all the species examined except one and occur for the most part on the dorsum and in connection with the cerarii, although they may at times appear on the venter as well. It is probable that the number of these pores is more or less constant for each species, but, aside from those occurring in the cerarii, it appears impracticable to make use of them. They are too numerous to count and a very slight difference in the treatment of specimens makes a marked difference in the visibility of the pores and hence in their apparent numbers. The number of these pores occurring in the cerarii, however, is of much significance.

The pores of the other two types are circular. Of these types, one, herein spoken of as the "multilocular type" (fig. 16b), occurs for the most part on the venter of the abdomen and appears to be especially concerned with the production of the ovisac. In a few species, notably in certain of those herein referred to the genus *Trionymus,* these pores are found upon the dorsum of the abdomen as well. Aside from this they appear to present few possibilities of use.

The third type, herein spoken of as the "quinquelocular type" (fig. 16c), occurs in but one species (*Heterococcus arenae* n. gen. and sp.), where they entirely replace the pores of the triangular type.

Body setae.—The body setae, especially those of the dorsum, frequently afford good specific characters. Their number, shape, size, and distribution are all worthy of consideration. The ventral setae are much less significant and I have not attempted to use them.

Anal ring and anal lobe setae.—In some species these afford fairly good characters which may perhaps best be expressed in terms of their actual length, and their relative length as compared with each other. The actual length, however, is difficult to obtain with accuracy, due to the fact that the setae are usually bent and for the purposes of this paper I have made but little use of this character.

Anal Ring.—The character of the anal ring has in the past been used to some extent in defining certain of the larger groups, but it is questionable whether the grouping thus obtained is at all natural. On the basis of the compound setiferous anal ring the Ortheziinae are more closely related to the Pseudococcine group than to the Monophlebinae, yet the probabilities are that the reverse of this is true. To some extent the anal ring is of generic value, but it needs to be supplemented by other characters. In one case I have found it of real specific value and in a few other cases it is of some assistance.

But little reliance should be placed upon the number of hairs on the anal ring in forming conclusions as to the relationships of genera. Brain (2) has referred the genus *Puto* to the Eriococcini because of the presence of eight hairs on the anal ring, yet this genus most certainly has nothing to do with *Eriococcus.* The genus *Ceroputo* was originally separated from *Puto* largely because of a difference in the number of hairs on the anal ring, yet other evidence indicates that this division is undesirable. *Lachnodius* has as many as 20 hairs on the anal ring, yet in other respects is clearly Pseudococcine.

Spiracles.—I have not been able to see that the spiracles merit any very special consideration in this group except in cases such as the genus *Antonina,* where they are extraordinarily large.

Larvae

The first stage larvae of all the species examined by me have six-segmented antennae except in the genus *Puto,* in which the antennae are seven-segmented. Except in the genus *Antonina* the larvae of the female differ from the adult female in the reduced number of antennal segments, the somewhat stouter character of the legs and in a general reduction of the number of pores and spines. There appear to be four instars. Specimens in the first two instars are hardly recognizable specifically, but specimens in the third instar can usually be recognized as easily as can the mature females. Specimens in these stages may be distinguished from the adult female by the apparent absence of the vaginal opening.

The larvae of the males of *Pseudococcus,* and in all probability of most of the other genera, do not differ in the first instar from the larvae of the female, but in the second instar the anal ring is simple and hairless, the mouthparts are entirely lacking, and the cerarii are represented merely by paired, slender setae. A notable exception is presented by the genus *Puto,* in which the second stage larvae of the males are indistinguishable from the second stage larvae of the females. In all cases investigated the larvae form a small waxen cocoon in which pupation

takes place. An examination of larvae of the males of several species has revealed no characters by which the species can be determined.

Adult Male

The adult male is alate in some species and apterous in others, although the wings are usually present. Except for this character most of the males present few features that can be utilized for systematic purposes, and the difficulty of procuring specimens effectually precludes their use. Attempts to found genera or subgenera upon the character of the males alone, as has in one or two instances been done, are hardly to be commended. The primary purpose of this paper being to aid in the determination of species, the males have been used only in cases where such action could not well be avoided.

SECRETIONS

The nature and disposition of the waxy secretions have been much relied upon in this group for specific differentiation and even to some degree in the formation of generic concepts. The fact has consistently been ignored by some authors, that these secretions are not the insect itself, and little or no attempt has been made to correlate them with morphological characters. Furthermore the fact has frequently been overlooked that similarity in secretionary covering does not of necessity imply similarity in structure. We thus have *Erium lichtensioides* redescribed as *Eriococcus artemisiae* and *Cryptoripersia salina* likewise referred to *Eriococcus* solely on the basis of the fact that both are enclosed in a complete sac, although neither has anything to do with the genus *Eriococcus*. For the same reason we have the published record of the occurrence of a certain species of *Eriococcus* in Japan, while the specimens upon which the record was based are of a species of *Antonina*. We have *Pseudococcus eriogoni* referred to the genus *Erium* because it is enclosed in a sac, although it certainly has little else in common with the type of that genus. Nor is this by any means the complete list of such errors.

In this connection we may recall the words of Maskell (8) which might well serve as the creed of Coccidologists, "On the other hand (rightly as it seems to me), I have always insisted that true Coccid classification should depend upon the anatomical characters of the insects themselves, and that mere external features, visible to the naked eye or an ordinary lens, are but secondary." It is only through the unreserved acceptance of this idea with the adoption of the methods necessary in order to carry it out that progress in the study of this group can be made.

All of this is not to be interpreted as a contention that the secretions are entirely valueless for taxonomic purposes. There unquestionably exists a very close correlation between the nature of the secretions and

that of the structures by which they are produced, a correlation that in many cases can be directly traced. It is in fact possible to gain a very accurate conception of the appearance of a species in life from a consideration of its morphology alone and, conversely, it is possible to gain some idea of the morphology of a species from a consideration of its appearance in life. It is only in the light of this that most of the existing descriptions are at all intelligible.

The lateral waxy tassels or "filaments" which are so conspicuous in many species of this group, are produced by the cerarii and their form and size are directly dependent upon the nature of the cerarii. If the cerarii are lacking there will be no tassels, and if there are no tassels the cerarii are lacking or very weakly developed. If the cerarii contain a large number of pores, cerarian spines or auxiliary setae, the tassels will be strongly developed, and if the tassels are of unusual length or size we may predict that the cerarii will present a corresponding development, although we cannot say exactly what form this development will take. In other words, similar tassels may be produced by a quite different arrangement of the various elements of the cerarii as is shown in the case of *Pseudococcus maritimus* and *P. citrophilus.*

The presence of glassy waxen threads such as appear in *Pseudococcus virgatus* or *Phenacoccus stachyos* is unmistakable evidence of the presence of some sort of large pore or duct, although the exact nature of this pore or duct can not be predicted. I have been unable, however, to trace the correlation between the presence of dorsal lumps of wax, such as appear in *Pseudococcus nipae* and *P. aurilanatus,* and any morphological elements, nor have I been able to account for the formation of a complete sac in some species and not in others. It is possible that this is dependent upon the physiology of the insect as is the case when the wax is yellow instead of the usual white. The correlation between the ovisac and the ventral glands by which it is produced is likewise too subtle to be traced. I cannot say why the ovisac of one species is loose and fluffy while that of another is firm, or why one is short and another is long. It is by no means impossible, however, that sufficiently careful and extended studies may throw some light upon these difficulties.

BIOLOGY

There has always been more or less of a tendency among students of the Coccidae to name species on the basis of differences in host plant and habitat. In a group such as this, where tangible structural differences are supposedly or actually few, it is difficult to resist this tendency, yet it must be resisted if we are to avoid confusion of the most serious kind. Essig, in separating his *Pseudococcus bakeri* from his previously

described *Pseudococcus obscurus,* stated that ". . . it did seem very improbable that the same species found on the roots of *Opuntia* at Los Angeles, could be synonymous with a species found working on the new bark of *Sambucus glauca* (Elder) at Santa Paula, 60 miles away." On this basis it would seem even more improbable that the species found on *Opuntia* at Los Angeles should be the same as a species found feeding on the bark of wild cherry in New York. Yet the evidence now available indicates that both the species on *Opuntia* and the species on *Sambucus* are identical with one found in New York on wild cherry.

The apparent anomalies which we encounter if host and biological differences be disregarded will usually disappear as our knowledge increases and at the worst are as nothing in comparison with the anomalies which appear if the morphological evidence be disregarded in the same manner. It is certainly possible, if not even probable, that there exist forms behaving for all practical purposes as distinct species, yet which are not separable by any morphological characters that we are able to appreciate. Indeed, it may eventually be worth while to designate some of these forms by names, but it seems hardly desirable to take such a step until all other possibilities have been exhausted.

For the purposes of the present paper all evidence other than that of morphology has been strictly disregarded. This action has been taken not from a belief that biological evidence is always entirely valueless, but from a conviction that it is extremely dangerous when not fully understood. It is too often merely misleading.

SYSTEMATIC TREATMENT

DEFINITION OF THE GROUP

The vernacular term "mealy bugs" has been used in the title of this paper chiefly because of a doubt as to the scientific term that should be applied. Whether the group of genera commonly included under this term should be regarded as a tribe, the Pseudococcini, of the subfamily Dactylopiinae, or as a subfamily, the Pseudococcinae, or as a family, the Pseudococcidae, of a superfamily, the Coccidoidea, is open to debate. Whatever status may be assigned to them it appears quite certain that the genera herein discussed, together with certain others, form a natural group quite distinctly separated from the remainder of the Coccidae, a group that does not include such forms as *Dactylopius, Eriococcus, Asterolecanium* and other genera of these types with which it is associated in the Fernald Catalogue. However, this is a question which as far as this paper is concerned is a secondary issue, and I have chosen to employ a vernacular term which is in general quite well understood.

The group of genera included may be defined by the following characters. Coccidae with at least one pair of dorsal ostioles; with entally truncate cylindrical wax ducts; commonly with at least one pair of cerarii; the adult female either with well developed legs or antennae or with these organs vestigial or entirely lacking, commonly more or less covered with cottony or mealy secretion or enclosed within a cottony or felted sac; without abdominal spiracles; posterior end of the abdomen neither cleft nor pygidiform; never with 8-shaped pores.

The extent of the group thus defined is somewhat problematical, but from the material available to me for study and from the published descriptions it appears that the following genera may be regarded as belonging here: *Antonina, Cryptoripersia, Erium, Geococcus, Lachnodius, Natalensia, Phenacoccus, Pseudococcus, Rhizoecus, Ripersia, Ripersiella, Trabutina, Trionymus and Tylococcus.* The genera *Cryptococcus* and *Fonscolombia* (at least *F. fraxini*) are almost certainly Eriococcine although their position in the Fernald Catalogue would indicate relationship with *Pseudococcus.* Through the kindness of Mr. E. E. Green I have been enabled to see specimens of both of these genera and in neither *Cryptococcus fagi* nor *Fonscolombia fraxini* are the dorsal ostioles pres-

ent, while in both species the ducts are distinctly of the Eriococcine type. Certain other genera remain to be elucidated before their position can be determined.

GENERIC CONCEPTS

As I have stated in an earlier paragraph the present generic concepts in this group are based largely upon the number of segments in the antennae of the adult females. The splendid simplicity of this arrangement is indeed attractive. We need only name a genus to correspond with each different number of antennal segments, with perhaps a few others for the reception of "aberrant" forms, and the system is complete. This is in fact practically what has been done. However, the unnatural character of the groups thus obtained has in part been recognized and the system has not been strictly adhered to, with the result that its simplicity has been somewhat marred. The genus *Ripersia* was originally established for the reception of forms with six-segmented antennae, but the majority of the species now referred to it have seven. *Pseudococcus* was intended for forms with eight-segmented antennae, but it now includes species with seven segments as well. As a consequence of this it appears that in several instances a species has been referred to one genus or another simply because "it looks like a *Ripersia*" or a *Pseudococcus* as the case may be.

I have attempted in the present paper to utilize other characters than the antennae for the recognition of generic groups. For this purpose the cerarii have seemed most useful, the number of pairs present being considered as diagnostic. It must be admitted that the groupings thus obtained are not entirely satisfactory, even with as few species as are here considered. It is not at all improbable that a reduction in the number of pairs of cerarii might occur in groups that are but little related, and in fact this appears to have happened. Nevertheless at its worst a system based fundamentally upon this character is much more satisfying than one based upon the antennae, and when supplemented by the other characters that are available seems to approximate a natural arrangement.

I wish specifically to disclaim any attempt to limit or define the genera here dealt with except as they concern the limited fauna discussed. The number of species available to me for examination is sufficient merely to indicate something of the difficulties that must be overcome before any final definitions can be formed. The task is one for a student who has before him a very large proportion of the known species and must not be undertaken on the basis of any purely local fauna.

SYNONYMICAL LIST OF NAMES APPLIED TO CALIFORNIA SPECIES

Note: synonyms are in italics; the genus *Dactylopius* (as formerly understood) being a synonym of *Pseudococcus* is not included in the list.

Genus **PSEUDOCOCCUS** Westwood

agrifoliae Essig.
    Pseudococcus quercicolus n. sp. (in part).
    Trionymus villosa (Ehrh.) (in part).
andersoni (Coleman).
    Pseudococcus ryani (Coq.).
affinis (Maskell).
artemisiae (Essig).
    Erium lichtensioides (Ckll.).
aurilanatus (Maskell).
azaleae (Tinsley).
bakeri (Essig).
    Pseudococcus maritimus (Ehrh.).
calceolariae (Maskell).
    Trionymus calceolariae (Maskell).
citri (Risso).
citrophilus Claussen.
comstocki (Kuwana).
crawii (Coq.) (as to female).
    Pseudococcus quercus (Ehrh.)
crawii (Coq.) (as to male).
    Puto yuccae (Coq.).
cupressi Coleman.
    Puto cupressi (Coleman).
cupressicolus n. sp.
dudleyi (Coleman).
    Pseudococcus ryani (Coq.).
eriogoni (Ehrh.).
    Erium eriogoni (Ehrh.).
    Pseudococcus yerba-santae Essig.
ephedrae (Coq.).
krauhniae (Kuwana).
longisetosus n. sp.
longispinus (Targ.).
maritimus (Ehrh.).
    Pseudococcus bakeri Essig.
    Pseudococcus obscurus Essig.
nipae (Maskell).
    Pseudococcus pseudonipae (Ckll.).
obscurus Essig.
    Pseudococcus maritimus (Ehrh.).
omniverae Hollinger.
    Pseudococcus maritimus (Ehrh.).

quercicolus n. sp.
Pseudococcus agrifoliae Essig (in part).
quercus (Ehrh.).
Pseudococcus crawii (Coq.).
ryani (Coq.).
Pseudococcus andersoni (Coleman).
Pseudococcus dudleyi (Coleman).
salinus (Ckll.).
sequoiae (Coleman) (as to female).
Pseudococcus ryani of authors (not of Coq.).
sequoiae (Coleman) (as to male).
Puto cupressi (Coleman).
smithii (Essig).
Trionymus californicus Ehrh. (in part).
Trionymus smithii (Essig) (in part).
solani of authors (not of (Ckll.).
Phenacoccus solani n. sp.
timberlakei Ckll.
yerba-santae Essig.
Pseudococcus eriogoni (Ehrh.).

Genus **PHENACOCCUS** Ckll.

artemisiae Ehrh.
bahiae Ehrh.
Puto yuccae (Coq.).
colemani Ehrh.
eriogoni n. sp.
kuwanae Coleman.
osborni Sanders.
Phenacoccus stachyos Ehrh.
ramonae Essig.
Puto yuccae (Coq.).
simplex King.
solani n. sp.
Pseudococcus solani of authors (not of Ckll.).
stachyos Ehrh.
Phenacoccus osborni Sanders.
Phenacoccus pettiti Hollinger.
yuccae (Coq.).
Puto yuccae (Coq.).

Genus **CEROPUTO** Sulc.

Here regarded as a synonym of *Puto*.

arctostaphyli (Coleman) (Nomen nudum).

Genus **PUTO** Signoret.

ambigua (Fullaway).
Ceroputo ambigua Fullaway.

cupressi (Coleman).
Pseudococcus sequoiae (Coleman) (as to male).
Pseudococcus cupressi Coleman.
yuccae (Coq.).
Ceroputo bahiae (Ehrh.).
Phenacoccus bahiae Ehrh.
Pseudococcus crawii (Coq.) (as to male).
Phenacoccus ramonae Essig.
Ceroputo yuccae (Coq.).
Phenacoccus yuccae (Coq.)
Ceroputo yuccae var. *ceanothi* Ckll.
yuccae var. *ceanothi* Ckll.
Puto yuccae (Coq.).

Genus **HETEROCOCCUS** new genus.

arenae n. sp.

Genus **TRIONYMUS** Berg.

bromi n. sp.
calceolariae (Maskell).
Pseudococcus calceolariae (Maskell).
californicus Ehrh.
Ripersia smithii Essig (in part).
distichlii n. sp.
festucae (Kuwana).
Ripersia festucae Kuwana.
grindeliae n. sp.
smithii (Essig).
Ripersia smithii Essig (in part).
Pseudococcus smithii (Essig) (in part).
villosa (Ehrh.).
Ripersia villosa Ehrh.
Pseudococcus agrifoliae Essig (in part).

Genus **CRYPTORIPERSIA** Ckll.

salinus (Ehrh.).
Eriococcus salinus Ehrh.

Genus **RIPERSIELLA** Towns.

kelloggi Ehrh.

Genus **ERIUM** Maskell.

eriogoni (Ehrh.).
Pseudococcus eriogoni (Ehrh.).
lichtensioides (Ckll.).
Eriococcus artemisiae Kuwana.
Eriococcus artemisiae var. *catalinae* Ehrh.
Pseudococcus artemisiae Essig.
Pseudococcus hymenocleae of Essig (not of Ckll.).

Genus **ANTONINA** Signoret.

crawii Ckll.

KEY TO GENERA REPRESENTED IN CALIFORNIA

Note: This and succeeding keys are based upon carefully stained material. The key to genera will apply to non-stained specimens, the keys to species will not. It is assumed that satisfactory preparations will be available and no attempt has been made to provide for the determination of species upon the basis of any other.

1. Posterior end of the abdomen of the adult female deeply invaginated, the anal ring at the inner end of this invagination . . . . . *Antonina*
   Posterior end of the abdomen not invaginated 2
2. Dorsum of the abdomen with circular pores only . . . . . *Heterococcus*
   Dorsum of the abdomen with triangular pores 3
3. With a denticle on the face of the tarsal claws 4
   Without a denticle on the face of the claws 5
4. With a continuous series of conspicuous, chitinized areas about the margin of the body . . . . . *Puto*
   Chitinized areas, if present, confined to the posterior end of the abdomen . . . . . *Phenacoccus*
5. With more than four pairs of cerarii . . *Pseudococcus*
   With not more than four pairs of cerarii 6
6. Antennae of the adult female very short, 5-segmented, set close together at the front of the head . *Ripersiella*
   Antennae of the adult female at least 6-segmented, not set close together at the front of the head 7
7. Dorsum of the abdomen beset with short, stout "spearhead-shaped" spines . . . . . *Erium*
   Dorsum of the abdomen with slender spines or setae 8
8. Anal ring on the dorsum at some distance from the posterior end of the abdomen, antennae in all stages 6-segmented . . . . . *Cryptoripersia*
   Not so: antennae of the adult female 7-8-segmented . . . . . *Trionymus*

Genus **PSEUDOCOCCUS** Westw.

Coccidae of the type described above; without a tooth or denticle on the face of the tarsal claw; with not more than 17 pairs of cerarii and sometimes with not more than 5 distinct pairs; antennae of the adult female 7- or 8-segmented, usually the latter; male minute, the male larvae

after the first molt without mouth-parts or cerarii and with a simple, non-setiferous anal ring.

Type of the genus *Pseudococcus longispinus* (Targ.)

Notes: As the genus is thus defined the species found in California form a quite homogeneous group except for four species in which there has been a reduction in the number of pairs of cerarii. In *P. eriogoni* the cerarii are lacking on the head and also behind the eyes, there being in all but 9 or 10 pairs instead of the usual 17. In *P. salinus* certain of the cerarii along the lateral margins just behind the eyes are lacking. Both of these species, however, seem clearly to belong to this group. In *P. nipae* there is a reduction in the number of cerarii accompanied by a tendency for the cerarian spines to be so widely separated that in the adult their identity is obscured. In *P. aurilanatus* there are not more than five or six pairs of recognizable cerarii and in the anteriormost of these the spines are so small and so widely separated that they are scarcely to be recognized. This species, in fact, departs so widely from the typical form of the genus that I am inclined to believe it should be removed. Nevertheless such action would be at present unjustifiable and I retain it in *Pseudococcus* in spite of the discord that it causes.

The distinction that I have drawn between *Pseudococcus* and *Trionymus* is clear enough as far as the type species of the two genera are concerned, but gradatory forms may make it difficult to maintain.

KEY TO CALIFORNIA SPECIES

1. Anal lobe cerarii with as many as 10 cerarian spines . . . . . *crawii* (Coq.)
   Anal lobe cerarii with not more than 2 cerarian spines 2
2. Anal ring very weakly chitinized, almost simple, presenting a crescentic appearance . . *salinus* (Ckll.)
   Anal ring strongly chitinized, distinctly compound, not presenting a crescentic appearance 3
3. With no auxiliary setae in the cerarii anterior to the last two abdominal pairs 4
   With auxiliary setae in most or all of the cerarii 12
4. With no definite cerarii anterior to the last 5-6 abdominal segments . . . . . *aurilanatus* (Mask.)
   With cerarii on the head and thorax 5
5. Cerarian spines in all except the anal lobe cerarii tending to be widely separated, dorsal body setae short, stout and conical . . . . . *nipae* (Mask.)
   Cerarian spines close together in all the cerarii, dorsal body setae slender or at least not short and conical 6
6. With a large, well defined, chitinized area surrounding the anal lobe cerarii . . . *timberlakei* (Ckll.)

Without a definite chitinized area about the anal lobe cerarii 7

7. Pores of the anal lobe cerarii numerous, arranged in a crowded, circular area about the cerarian spines 11
Pores of the anal lobe cerarii few, not thus arranged 8

8. With no cerarii on the head anterior to the eyes, in all with not more than 9-10 pairs . . *eriogoni* (Ehrh.)
With cerarii on the head anterior to the eyes, in all with 17 pairs 9

9. With a narrow, chitinized bar on the ventral side of the anal lobes, lobes extending in from the base of the anal lobe seta 10
Without such a structure . . . . *sequoiae* (Coleman)

10. Tips of cerarian spines and dorsal body setae flagellate . . . . . *krauhniae* (Kuw.)
Tips of cerarian spines and dorsal body setae not flagellate . . . . . *citri* (Risso)

11. With not less than 15 pairs of cerarii . . . *ryani* (Coq.)
With not more than 11 pairs of cerarii *cupressicolus* n. sp.

12. With a well defined, chitinized area surrounding the anal lobe cerarii 15
With no chitinized area surrounding the anal lobe cerarii 13

13. With a chitinized area on the ventral side of the anal lobes 14
Without a chitinized area on the ventral side of the anal lobes . . . . . *cupressicolus* n. sp.

14. Pores of the anal cerarii arranged in a crowded, circular group; body setae short, inconspicuous . . . . . *maritimus* (Ehrh.)
Pores of the anal cerarii scattered, body setae numerous and long, giving the body a conspicuously hairy appearance . . . . . *longisetosus* n. sp

15. With chitinized areas surrounding both penultimate and anal lobe cerarii 18
With a chitinized area surrounding the anal lobe cerarii only 16

16. Pores of the anal lobe cerarii arranged in a crowded, circular group . . . . . *maritimus* (Ehrh.)
Pores of the anal lobe cerarii scattered 17

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17. With a chitinized area on the ventral side of the anal lobes . . . . . *comstocki* (Kuw.)
    Without such a structure . . . . . *quercicolus* n. sp.
18. Pores of the anal lobe cerarii arranged in a crowded, circular group . . . . . *longispinus* (Targ.)
    Pores of the anal lobe cerarii scattered . . . . . *citrophilus* (Claussen)

Pseudococcus affinis (Maskell).

1914. *Pseudococcus affinis* (Maskell); Essig, Mon. Bull. Calif. State Com. Hort. 3:106.

Essig states that the U. S. Dept. of Agriculture has recorded this species as attacking *Anemone* sp. in California. However, there is no other record of its occurrence in the state and it is not considered in the present paper.

Pseudococcus aurilanatus (Maskell).

1889. *Dactylopius aurilanatus* Maskell, Trans. New Zealand Inst. 11:151.
1915. *Pseudococcus aurilanatus* (Mask.); Essig, Inj. & Benef. Ins. Calif., 2d ed., 125, fig. 106.

In life. Of a deep red or purple color, the waxy secretion of a bright yellow color and arranged in tufts on the dorsum and along the margins. Ovisac short, quite firm, white.

Morphological characteristics. Body contents black; derm blue-green; cerarii present on the last five or six abdominal segments only, each with two cerarian spines, those in the anteriormost pairs are so small and so widely separated as to be scarcely recognizable. Anal lobe cerarii surrounded by a small, indefinite, chitinized area and accompanied by two or three slender setae and a few pores. Remaining cerarii with neither grouped pores nor auxiliary setae. Dorsal body setae small, conical, somewhat constricted at the base, scattered, few in number except on the head. Tubular ducts few, very small, without a raised rim about the mouth. Anal lobe setae about equal to the anal ring setae. Antennae 7-8-segmented.

Type host and locality. From *Araucaria* in Australia.

Host and distribution. Essig states that this species occurs on different species of *Agathis* as well as on *Araucaria*. Its out-of-door range in this state is not definitely known, but it occurs on *Araucaria* out of doors at Mountain View in Santa Clara County.

Authentication. Not authenticated. Agrees with original description.

Notes: In many respects this species departs rather widely from typical *Pseudococcus* and in part it is morphologically much nearer *Erium* or even *Trionymus*. I shall not, however, attempt to remove it from *Pseudococcus*.

Pseudococcus azaleae (Tinsley).

1898. *Dactylopius azaleae* Tinsley, Can. Ent. 30:319.
1914. *Pseudococcus azaleae* (Tins.); Essig, Mon. Bull. Calif. State Com. Hort. 3:108.

This species was originally described from specimens taken from azalea in a Japanese nursery at San Jose. It is not now known to occur in this state and is not here considered.

Pseudococcus citri (Risso).

Plate 1, figs. 7, 9.

1910. *Pseudococcus citri* (Risso); Essig. Pomona Col. Jn. Ent. 2, no. 4:289-320, figs. 111-119.

Note: The literature in regard to this species is so voluminous that only the reference to the above admirable article is given.

In life. Covered with thick white cottony wax, the marginal tassels short but distinct, becoming somewhat longer posteriorly with the caudal pair equaling perhaps one-fourth the length of the body. Eggs deposited in large, more or less irregular masses.

Morphological characteristics. With 17 pairs of cerarii, none of which contain more than two conical spines, these quite large, the anal lobe pair not exceeding in size those preceding it. All the cerarii without auxiliary setae and with very few pores. Anal cerarii without a definite chitinized area, but occasionally showing a very slight chitinization. Ventral side of each anal lobe with a narrow, very distinct, chitinized area extending in from the base of the anal lobe seta and bearing a small hair at about midway of its length. Dorsal body setae scattered, quite small and slender. Cylindrical ducts very few in number, of the small type, without raised rim at the mouth. Anal lobe setae somewhat longer than anal ring setae.

Immature female differing but little from the adult.

Hosts and distribution. In the northern part of the state this species appears to be confined to greenhouses, although I have at hand specimens taken from citrus at Marysville. In the vicinity of Stanford University it does not appear to live out of doors. Its distribution and status in the southern part of the state are too well known to require comment here.

Authentication. Common repute.

Notes: The only California species with which this is likely to be confused are *P. krauhniae* (Kuwana) and *P. eriogoni* (Ehrh.). It is indeed very similar to the former, but may readily be distinguished by the fact that the tips of none of the spines are prolonged into a sort of flagellum and by the much scantier covering of hairs. From the latter it may always be distinguished by the presence of cerarii between the eyes.

The chitinized area on the ventral side of the anal lobes is remarkably constant in size and shape. I have examined specimens from cacao and an unknown host from Samoa, greenhouse plants from Ohio and Stanford University and from citrus from southern part of California and find practically no variation, except for a very weak chitinization about the anal cerarii of the Samoan specimens.

Pseudococcus citrophilus Claussen.

Plate 1, fig. 6.

1915. *Pseudococcus citrophilus* Claussen, Calif. Agr. Exp. Sta. Bull. **258**:30-35, figs. 1b, 6, 7.

In life. Covered with white wax except for four longitudinal rows of conspicuous impressed dots on the dorsum. Marginal tassels very short and quite stout. The single pair of elongated caudal tassels are from one-fourth to one-third the length of the body and are likewise quite stout. Oviparous.

Morphological characteristics. 17 pairs of cerarii present, the anterior 3-4 pairs with three conical spines, the remainder with but two, those of the anal pair considerably larger than those of the others. Each lateral cerarius with numerous pores and four or more auxiliary setae. Penultimate pair surrounded by a small circular chitinized area containing numerous pores. Anal lobe pair surrounded by a large, well defined, more or less oval chitinized area with many pores, which are more or less scattered, and with several long, slender setae. Ventral side of each anal lobe with a small but distinct chitinized area extending in from the base of the anal lobe seta, bearing two slender setae at its posterior tip. Dorsal body setae small and slender, not numerous. Cylindrical ducts of two sizes present, the smaller without an elevated rim at the mouth predominating. Anal lobe setae equaling anal ring setae.

Immature female in general resembling the adult, differing in the weaker development of the cerarii.

Type host and locality. These have not been distinctly stated (the species has not been formally described), but are probably to be taken as citrus, at Upland, Calif.

Hosts and distribution. The species is chiefly known as a pest of citrus fruits in the southern part of the state. However Claussen has recorded it from a wide range of hosts in that section. It also occurs on oranges at Irvington in Alameda County and has been taken from laurel in a greenhouse at Oakland.

Authentication. Metatype material examined.

Notes: The longitudinal rows of impressed dots in the living insect are quite distinctive. Morphologically the species most nearly resembles *P. comstocki* (Kuwana) from which it can be distinguished only by the presence of a chitinized

area about the penultimate cerarii as well as about the anal lobe pair. It also somewhat resembles *P. quercicolus* n. sp., from which it differs in the same manner as from *P. comstocki* and further by the presence of a chitinized ventral area on the anal lobes.

Pseudococcus comstocki (Kuwana).

Plate 1, fig. 2.

1902. *Dactylopius comstocki* Kuwana, Proc. Calif. Acad. Sci., (3) 3:52.

In life. Almost identical with *P. maritimus* (Ehrh.), the lateral tassels short and slender, the caudal pair one-third or one-half the length of the body. Ovisac not seen.

Morphological characteristics. With seventeen pairs of cerarii, of which the first six or seven pairs have three or four conical spines, the remainder having but two. The spines of the anal lobe cerarii are considerably larger than any of the others. Lateral cerarii with three or four auxiliary setae and a small cluster of pores. Anal lobe cerarii surrounded by a large, oval, chitinized area, which is attenuated posteriorly, extending back to the anal lobes, and which bears several slender setae and numerous pores, the latter showing some tendency to concentrate about the cerarian spines. Ventral side of the anal lobes with a small, but constant, triangular, chitinized area extending in from the base of the anal lobe setae. Dorsal body setae numerous, slender and rather long. Triangular pores very abundant over the body, mingled with many tubular ducts, of which the majority are without a raised rim about the mouth. Anal lobe setae about equaling anal ring setae or perhaps a trifle longer.

Immature female in general resembling the adult female.

Type host and locality. From mulberry, Akabane, Japan.

Hosts and distribution. Not previously recorded from the U. S. I have specimens taken by Professor Doane from mulberry and maple on Staten Island, N. Y., and also specimens from *Pinus radiata* on the campus of Stanford University.

Authentication. Type specimens examined.

Notes: It is reasonable enough to find this species on mulberry and maple in Japan and on the same hosts in New York, for we need only assume that it has been introduced on one of these hosts, but it is somewhat difficult to believe that the species taken from pine in California is the same. However, I can find not the slightest ground upon which to effect a separation and I do not propose to brave the pitfalls which one will surely encounter if he disregard the evidence of morphology and venture to discriminate between species upon the shifting and inconsistent basis of hosts and biology alone.

I have taken this species in California only upon *Pinus radiata* upon the Stanford campus, where it is quite common, although by no means abundant.

This is very near *P. citrophilus* Claussen, from which it differs only in the absence (in life) of the longitudinal rows of impressed dots on the dorsum and the absence of a chitinized area about the preanal cerarii.

Pseudococcus crawii (Coq.).

Plate 1, fig. 1.

1889. *Dactylopius crawii* Coquillet, West. Amer. Scientist. **6**:123. (As to the female.)
1900. *Dactylopius quercus* Ehrhorn, Can. Ent. **32**:220.
1914. *Pseudococcus crawii* (Coq.); Essig, Mon. Bull. Calif. State Com. Hort. **3**:117, fig. 32.

In life. "The bodies of the females are light yellow and covered with thick plates of white cottony material which entirely hides the color. The lateral filaments are very distinct, being about one-fourth as long as the width of the body. The anal filaments vary from one-third to one-half the length of the body. They usually form a sharp angle at the posterior end and in some individuals the ends are curved inwardly." (Essig.) The females are viviparous, the young being placed in a pad-like ovisac.

Morphological characteristics. Seventeen pairs of cerarii present, all with more than two conical spines, the anal lobe pair containing 15 to 20, the others from 3 to 6. The lateral cerarii are without auxiliary setae and are accompanied by a small cluster of pores. The anal lobe pair are borne upon a large, nearly circular and somewhat protuberant chitinized area, the spines being accompanied by numerous scattered pores and several slender setae. In some cases the penultimate cerarii are also surrounded by a more or less distinct area. Ventral side of the anal lobes without chitinized area. Dorsal body setae very few, scattered and small. Numerous triangular pores scattered over the body, mingled with relatively few, large, cylindrical ducts. Anal lobe setae equaling anal ring setae.

Immature female differing but little from the adult.

Type host and locality. From *Ramona polystachya* (white sage) near Los Angeles, Calif.

Hosts and distribution. Common on the white sage throughout the southern part of the state, and according to Essig, occurring on the California sage (*Artemisia californica*) also. Also from *Quercus chrysolepis* and *Pasania densiflora* in the vicinity of Stanford University, and from *Adenostoma fasciculatum* in Marin County.

Authentication. Not authenticated. Specimens from the type host and location agree with the original description and belong to what is commonly accepted as this species.

Notes: Specimens of two species of *Pseudococcus* taken by me from *Quercus chrysolepis* near Stanford University were sent to Mr. Ehrhorn who identified one of them as his *Pseudococcus quercus*. I can find no basis for separating this from *P. crawii* in spite of the apparent anomaly presented by the wide difference in hosts. It is perhaps the most distinctive species occurring in the state and cannot be confused with any other.

I do not know that any notes on the male other than those in the original description by Coquillet have ever been published and I have not seen the male myself. However, it seems almost certain that the male described by Coquillet really belongs with *Puto yuccae* (Coq.), a species that also occurs upon the white sage, for this description applies throughout to a male of the latter genus.

Pseudococcus cupressicolus n. sp.

Plate 1, fig. 11.

In life. Living specimens have not been examined, but judging from the morphology of the species the insect will bear a pair of slender caudal tassels of perhaps one-half the length of the body, a series of much shorter tassels along the lateral margins of the abdomen with perhaps two or three very short pairs on the head.

Morphological characteristics. Antennae 7-8-segmented, both numbers frequently appearing in the same individual. Not more than 11 pairs of cerarii present, these appearing in a quite definite arrangement as follows: a pair on each abdominal segment, a pair opposite each anterior spiracle and each anterior leg, an ocular pair and a pair anterior to the eyes. There is a tendency for the cephalic and thoracic pairs to be lacking and any of these pairs may at times be present on one side of the body and not on the other. The cerarian spines are small in all except the anal lobe pair, in which they are conspicuously larger. The anal lobe cerarii include a circular cluster of many crowded pores which are not surrounded by a chitinized area. Remaining cerarii with few pores, either with or without two or three auxiliary setae, for the most part with but two cerarian spines, but at times with three. No chitinization on the ventral side of the anal lobes. Dorsal body setae numerous, very slender and quite long. Tubular ducts not strikingly abundant, all small and without a raised rim about the mouth. Anal lobe setae about equaling the anal ring setae.

Immature specimens differing from the adult in the reduction of the number of pores in the anal cerarii and in a tendency for the cerarian spines to be slender and elongated.

Type host and locality. From *Cupressus guadelupensis* at Riverside, Calif. A. F. Swain, collector.

Hosts and distribution. From the type host and from *Cupressus arizonicus* at Riverside.

Notes: Morphologically this most nearly resembles *P. ryani,* but it may readily be separated by the reduced number of cerarii, by the much more numerous dorsal body setae and by the marked tendency toward the development of auxiliary setae in connection with the cerarii.

Pseudococcus eriogoni Ehrh.

1899. *Dactylopius eriogoni* Ehrhorn, Can. Ent. 31:103.
1902. *Erium eriogoni* (Ehrh.); Cockerell, Ann. Mag. Nat. Hist., (7), 10:465.
1913. *Pseudococcus yerba-santae* Essig, Pomona Col. Jn. Ent. 2:85.

In life. Adult female enclosed in a more or less definite sac. Lateral tassels very short, confined to the posterior part of the body.

Morphological characteristics. Antennae of the adult female normally 8-segmented, sometimes 7-segmented. Cerarii reduced in number, there being but eight or nine pairs, counting forward from the anal lobes, and usually an ocular pair, but none on the head between the eyes. The ocular pair may contain several cerarian spines, the remaining cerarii have but two, all being quite small, the anteriormost almost merging with the body setae. In none are there any auxiliary setae except in the anal lobe pair, which has 3-5 small hairs, and in none is there any grouping of the pores. In some specimens there is a very small chitinized area on the ventral side of the anal lobes which in extreme cases somewhat resembles that found in *P. citri,* but this is variable in size and sometimes entirely lacking. Dorsal body setae quite numerous, slender. Triangular pores abundant, mingled with many large cylindrical ducts with a raised rim about the mouth, these in many specimens being quite striking by reason of their abundance. Anal lobe setae about twice as long as the anal ring setae.

Immature female in all essential respects resembling the adult.

Type host and locality. From the roots of *Eriogonum* sp. Stevens Creek, Santa Clara County, Calif.

Hosts and distribution. From *Eriogonum nudum,* Stevens Creek, Santa Clara County; *Viola sarmentosa* at the reservoir on Big Creek, Santa Cruz County; *Stachys* sp., Corte Madera Creek, near Stanford University; *Eriodictyon californicum,* Sespe Canyon, Ventura County; *Eriodictyon tomentosum,* Del Mar; ragweed, Upland, Calif.; *Ceanothus cuneatus,* southern California; *Erigeron* sp., locality unknown.

Authentication. Material from the type host and locality, agreeing with the original description.

Notes: I have not seen the types of this species, but I have at hand specimens taken from the roots of *Eriogonum* in the type locality and agreeing in all respects with the original description, which was probably based upon immature specimens. I have also examined the types of *P. yerba-santae* Essig and of *P. leptodontis* Claussen MSS. and am unable to regard either of these as in any way distinct.

While this is not a typical *Pseudococcus* its affinities appear to be entirely with that genus. The absence of cerarii between the eyes and along the anterior portion of the lateral margins should be sufficient to prevent confusion with any other species. The sac is by no means so definitely formed as the original description would indicate, the insects leaving it readily when disturbed.

Pseudococcus ephedrae (Coq.).

1890. *Dactylopius ephedrae* Coquillet, West Amer. Scientist 7:43.

In life. "Adult female elongate-ellipsoidal, from two and a half to three times as long as broad, dark olive, almost black, thinly covered with a snow-white mealy powder not entirely concealing the ground color; cottony appendages confined to posterior end of body, the longest less than half the length of the body. . . ." "The adult female secretes a layer of white cottony matter from the lower part of her body, and this is gradually extended upward until finally the entire insect is enclosed in a cottony sac." (Coquillet.)

Morphological characteristics. According to Coquillet's description the antennae are 8-segmented and the claw is without a denticle.

Type host and locality. From *Ephedra californica* in Los Angeles County.

Hosts and distribution. Known only from the original description.

Notes: This species has not been seen since it was originally described, and nothing can be added to the description. It may possibly be an *Erium.*

Pseudococcus krauhniae (Kuwana).

Plate 1, fig. 8. (Also see plate 1, fig. 7.)

1902. *Dactylopius krauhniae* Kuwana, Proc. Calif. Acad. Sci., (3), 3:55, pl. 9, figs. 39-40.

In life. "Enclosed in a cottony sac of irregular shape," (Kuwana).

Morphological characteristics. Seventeen pairs of cerarii present, all with but two spines, without auxiliary setae and with but very few pores. The cerarian spines are all practically of the same size and in all the tip is produced into a sort of flagellum. No chitinization associated with any of the cerarii. Ventral side of the anal lobes with a narrow chitinized bar extending in from the base of the anal lobe setae. Dorsal body setae very numerous, stout at the base, quite long and with the tips more or less flagelliform. Triangular pores numerous, intermingled with many small cylindrical ducts without a raised rim about the mouth. Anal lobe setae perhaps one and a half times as long as the anal ring setae.

Immature female not seen.

Authentication. Types examined.

Type host and locality. From *Krauhnia floribunda,* Yokohama, Japan.

Hosts and distribution. Among the material received from Mr. Essig is one slide labeled "From wisteria and persimmon," Nordhoff, which is unmistakably this species, the types of which are in the Stanford collection. It has previously been recorded only from Japan and once from quarantine in New Jersey, the latter record needing verification.

Notes: Morphologically this is very close to *P. citri,* but the curiously flagelliform spines and hairs, together with the abundance of dorsal body setae, is sufficient to separate it at once. It might perhaps be regarded by some as a "variety" of *P. citri,* but I believe it to be sufficiently distinct.

Pseudococcus longisetosus n. sp.

Plate 1, fig. 10.

In life. Thickly covered with white powdery wax, with short, stout lateral tassels which become somewhat longer posteriorly. Ovisac not observed.

Morphological characteristics. Antennae either 7- or 8-segmented in the adult female. With from 15 to 17 pairs of cerarii, the normal number, 17, generally being obscured either by the dropping out of one or two pairs or their merging with the body setae. The first three or four cerarii have usually three conical spines and the remainder two, although there is considerable variation, but the normal number for most of the cerarii is two, those of the ultimate pair being somewhat larger than any of the others. All cerarii with prominent auxiliary setae and numerous pores. The anal lobe cerarii have many scattered pores, and several long, stout hairs. Ventral side of the anal lobes with a small and rather irregular chitinized area, bearing two or three slender setae at its posterior margin. Dorsal body setae very numerous and unusually long, especially on the abdomen. Derm thickly beset with triangular pores and small cylindrical ducts without a rim about the mouth. Anal lobe setae about equal to the anal ring setae in length and accompanied by several minor setae of nearly their own length.

Immature female in general resembling the adult, but somewhat less hairy.

Male not definitely recognized, due to the association of this with another species, but an apterous male was observed that may perhaps belong with this.

Type host and locality. From beneath a stone, associated with ants, (*Cremastogaster lineolata*) on the mountain road above Woodside, San Mateo County, Calif., April, 1917.

Hosts and distribution. From the type station and from the underground stems of *Castilleia foliolosa* and *Orobanche tuberosa,* Coal Mine Ridge, near Stanford University, most abundant upon the latter host, and from roots of *Armeria vulgaris* on the cliffs at Pacific Grove.

Notes: In general this species most nearly resembles *P. maritimus,* differing, however, in the rather striking vestiture of long hairs and in the less marked concentration of the pores about the conical spines of the anal lobe cerarii.

On the basis of hosts this might be *P. aphyllonis* Ckll. which is recorded from *Orobanche* (*Aphyllon*) *fasciculatum* at Wentachee, Wash., but Mr. Morrison has furnished me with a sketch of the type of that species which proves that the two are quite different. The description of *P. formicarii* Ehrh. suggests some resemblances to that species.

Pseudococcus longispinus (Targ.).

Text figure 13; plate 1, fig. 4.

Note: The literature and synonymy of this species are so extensive that it is hardly desirable to present them here.

In life. Remarkable for the unusual development of the lateral and caudal tassels, those on the margins of the body equaling in length nearly half the width of the body and the caudal pair being at times actually longer than the body. Oviparous, the ovisacs more or less loose and elongated.

Morphological characteristics. Seventeen pairs of cerarii present, the first three or four pairs of these with three or four conical spines, the remainder with two. These increase gradually in size toward the posterior end of the body until the penultimate pair are reached and of these the spines are much larger than any preceding, while those of the anal lobe pair are still larger, being extremely stout. All of the cerarii with auxiliary setae and numerous pores. In the anal lobe and penultimate pairs the pores are concentrated into a crowded circular area about the cerarian spines. Penultimate cerarii surrounded by a circular chitinized area and the anal lobe pair by a large well-defined oval area. Ventral side of the anal lobes with a large, triangular chitinized area with the apex directed forward and with a narrow thickening along its median edge. Dorsal body setae few, slender. Triangular pores not numerous, intermingled with scattered tubular ducts of which a few have a raised rim about the mouth. Anal lobe setae shorter and more slender than anal ring setae.

Immature females differing from the adult chiefly in a slight reduction in the number of pores.

Hosts and distribution. Upon a very considerable range of hosts, out of doors in the southern part of the state. In the bay region it occurs only in greenhouses, where it chiefly infests ferns.

Authentication. Common repute.

Notes: The characters of the anal lobes are such that this species can hardly be confused with any other found in the state. I do not propose to enter into the discussion as to whether this should be called *longispinus* or *adonidum*. I retain the better known name.

Pseudococcus maritimus Ehrhorn.

Text figure 11; plate 2, fig. 13.

1900. *Dactylopius maritimus* Ehrhorn, Can. Ent. 32:315.
1909. *Pseudococcus obscurus* Essig, Pomona Col. Jn. Ent. 1:43.
1909. *Pseudococcus bakeri* Essig, Ibid. 2:334, fig.
1917. *Pseudococcus omniverae* Hollinger, Ann. Ent. Soc. Am. 10:271, fig. 31.

In life. Covered with thick, white, waxy powder, the lateral tassels rather short and slender, equaling perhaps one-fourth the width of the body, the caudal tassels longer, equaling at times half the length of the body. Eggs laid in loose, white, cottony masses.

Morphological characteristics.—With 17 pairs of cerarii of which the first two or three pairs have three or four cerarian spines, the remainder but two, the spines becoming larger toward the posterior end of the body. All cerarii with auxiliary setae and with numerous pores, the pores in the anal lobe pair being concentrated into a crowded, circular area about the cerarian spines. In some cases the anal lobe cerarii are surrounded by a weakly indicated chitinized area, in others this is entirely lacking. Ventral side of the anal lobes with a well-defined somewhat triangular chitinized area, varying somewhat in size but always present. Dorsal body setae few, slender. Triangular pores more or less numerous, intermingled with a few tubular ducts without a raised rim about the mouth. Anal lobe setae slightly shorter and slenderer than the anal ring setae.

Immature female differing but little from the adult.

Type host and locality. From roots of *Eriogonum latifolium* on the cliffs at Santa Cruz, Calif.

Hosts and distribution. I have at hand specimens of this species from wild cherry near New York City (R. W. Doane coll.) and from roots of clover at Medford, Ore., (M. N. Reeher coll.). It has been recorded from Missouri under the name of *P. omniverae* Hollinger. Within the state of California the list of hosts and localities is limited merely by the collecting that has been done. In the vicinity of Stanford University I have taken the species from tomato, roots of carnation, passion flower, *Quercus agrifolia, Magnolia,* sp., maple, *Crataegus* and *Pinus radiata.* In the vicinity of Fresno it is a pest on the grapes, and in the southern part of the state it is a serious enemy of the citrus fruits. It is probable that there is almost no cultivated or wild flowering plant upon which it will not feed.

Authentication. Specimens compared with type by Mr. Ehrhorn.

Notes: Specimens taken by me from the type host at Santa Cruz were forwarded to Mr. Ehrhorn, who identified them as his species, *P. maritimus.* I

have also examined the types of *P. obscurus* Essig and *P. bakeri* Essig, and can find no basis upon which to separate them from *maritimus*. This conclusion is supported by the fact that specimens taken from the type host and forwarded to Mr. C. P. Claussen were by him reared on green lemons. He informs me that he could not distinguish these from ordinary *P. bakeri*.

Mr. Claussen has proposed to separate the species occurring on grape at Fresno, being moved to this action chiefly by the behavior of certain parasites. In this I cannot concur.

It is unfortunate that a name so familiar as is *P. bakeri* should be replaced by one which has appeared but once in our literature, but there is no alternative. Even yet it is by no means certain that this name will stand, as the occurrence of the species in the Eastern states suggests the possibility that it has been described under some other name there. In fact I am inclined to suspect that the species which has passed as the "summer form" of *P. trifolii* Forbes may be identical with this.

I have received specimens of *P. omniverae* Hollinger through the kindness of Mr. Hollinger, and although the specimens are not strictly comparable due to differences in treatment, I regard this also as a synonym of *P. maritimus*.

Pseudococcus nipae (Maskell).

Plate 2, fig. 12.

1892. *Dactylopius nipae* Maskell, New Zealand Trans. **25**:232.
1897. *Dactylopius pseudonipae* Cockerell, Science Gossip, N. S., **3**:189, 302.
1908. *Pseudococcus nipae* (Maskell); Marchal, Ann. Soc. Ent. Fr. (8), **8**:236-39, figs. 7-8.
1914. *Pseudococcus pseudonipae* (Ckll.); Essig, Mon. Bull. Calif. State Com. Hort. **3**:120-1, fig. 34.
1915. *Pseudococcus pseudonipae* (Ckll.); Essig, Inj. & Benef. Ins. Calif. 2d ed., 132.
1917. *Pseudococcus nipae* (Maskell); Green, Ent. Mon. Mag. **53**:262-63, fig. 1.

In life. Covered with yellowish secretion arranged in conical humps. Divested of secretion the body is of an amber or orange-yellow color.

Morphological characteristics. The number of pairs of cerarii is somewhat difficult to determine, but there appear to be from 12 to 15 in all of which the cerarian spines are stout and conical In all except the anal lobe pair the cerarian spines are very widely separated and are recognizable only by their paired character, being unaccompanied by either grouped pores or auxiliary setae. In the anal lobe cerarii the cerarian spines are close together and are accompanied by two or three slender setae and a few grouped pores. Anal lobes quite prominent and with a small chitinized area on the ventral side extending in from the base of the anal lobe seta. Dorsal body setae few, rather small, stout, conical. Tubular ducts few, small without raised rim about the mouth. There appear to be no definite structures corresponding to the lumps of wax. Anal lobe setae somewhat shorter than the anal ring setae. Antennae normally 7-segmented. Legs rather short and stout.

Immature female differing from the adult chiefly in the fact that the cerarian spines are closer together.

Type host and locality. From *Nipa fruticans,* Demerara, British Guiana.

Hosts and distribution. This is a common greenhouse species occurring on palms. It is not known to occur out of doors in this state.

Authentication. Not authenticated. It is the species that commonly passes as *P. nipae* and *P. pseudonipae.* It agrees fairly well with the original description and very well with the descriptions of *P. nipae* given by Marchal and Green.

Notes: I can see no basis for the separation of *P. nipae* (Maskell) and *P. pseudonipae* (Ckll.). Specimens from Hawaii which pass there as *P. nipae* are certainly not different from those which pass here for *P. pseudonipae.*

Pseudococcus quercicolus n. sp.

Plate 2, fig. 18.

1910. *Pseudococcus agrifoliae* Essig, Pomona Col. Jn. Ent. **2**:147-148, figs. 60B, 60C. (Not of Essig, Ibid. 1:42.)
1911. *Pseudococcus agrifoliae* Essig; Smith, Ann. Ent. Soc. Am. **4**:316.
1913. *Pseudococcus agrifoliae* Essig; Smith, Pomona Col. Jn. Ent. & Zool. **5**:78.

In life. With rather long marginal tassels and a caudal pair of at least half the length of the body. Ovisac not observed.

Morphological characteristics. With 17 pairs of cerarii of which the anterior 3-4 pairs have 3-4 cerarian spines and the remainder but 2, those of the anal lobe pair much larger than any of the others. Lateral cerarii each with a small cluster of pores and with three or four auxiliary setae. Anal lobe cerarii surrounded by a distinct chitinized area, which does not extend back to the base of the anal lobe hair and which contains numerous scattered pores. Ventral side of the anal lobes without a chitinized area. Dorsal body setae, few, slender. Anal lobe setae about equaling anal ring setae.

Immature female in general closely resembling the adult.

Type host and locality. From *Quercus chrysolepis,* Stevens Creek, Santa Clara County, Calif.

Hosts and distribution. From the type host and from *Pasania densiflora* in the vicinity of Stanford University and from *Quercus agrifolia* near Claremont, Los Angeles County, Calif. There appears to be but one generation a year, this maturing in May or June in the vicinity of Stanford.

Notes: The problem of the proper name for this species presents a curious tangle. I have at hand the type slides of *Pseudococcus agrifoliae* Essig. The slide labeled "Type" contains mature females of the species herein described as *P. quer-*

cicolus n. sp. Another slide labeled "cotype" contains immature specimens of a species of *Puto*. Other slides not indicated as type material contain specimens of *Trionymus villosa* (Ehrh.) either alone or in company with immature specimens of *P. quercicolus*. None of the slides bear any date, but I am informed by Mr. Essig that they were not all collected at the same time.

The original description of the species cannot apply to the specimen labeled "type," for this description indicates that the antennae were 7-segmented. It does apply to *Trionymus villosa* (Ehrh.). The so-called type was evidently selected subsequent to the publication of the original description from the specimens described by Essig as the "summer form" of *P. agrifoliae*. In view of this it appears that the name *agrifoliae* cannot be used for this species, and for it I propose the name *quercicolus*.

It further remains to be decided what is to be done with the name *agrifoliae*. It probably is a synonym of *T. villosa* (Ehrh.), although none of the specimens of this species are included in the material bearing any type designation. The name might be used for the species of *Puto*, but there can be but little if any question that this is either *P. yuccae* (Coq.) or *P. koebelei* Ehrh., so that in any case the name becomes a synonym. Inasmuch as the original description applies especially to *T. villosa* I regard *agrifoliae* as a synonym of this and place the species of *Puto* as a misidentification.

Pseudococcus ryani (Coq.).

See plate 1, fig. 11.

1889. *Dactylopius ryani* Coquillet, West Amer. Scientist 6:122-123.
1903. *Dactylopius andersoni* Coleman, Jn. N. Y. Ent. Soc. 11:62-3, pl. 5, figs. 3-4.
1903. *Dactylopius dudleyi* Coleman, Ibid. 11:63-4, pl. 5, figs. 5-8.

In life. Covered with white, powdery wax, the lateral tassels very short, the caudal pair from one-half to one-third the length of the body.

Morphological characteristics. With 15-17 pairs of cerarii, of which the anterior 2-3 pairs have three conical spines and the remainder but two, these spines in all the cerarii being very small except for those of the anal lobe pair which are conspicuously larger than the others. All the cerarii without auxiliary setae and with a cluster of but a half-dozen pores, except the last which has several small hairs and numerous pores concentrated into a circular area about the conical spines, this area being slightly chitinized. Ventral sides of the anal lobes sometimes with a very small isolated chitinized area which may, however, be entirely lacking. Dorsal body setae few, small and slender. Triangular pores few; tubular ducts few, small, for the most part without raised rim about the mouth. Anal lobe setae about equaling anal ring setae.

Immature female not observed.

Type host and locality. From *Cupressus macrocarpa* near Los Angeles.

Hosts and distribution. Recorded by Coquillet from *Thuya orientalis* and *Araucaria excelsa* as well as from the type host near Los Angeles.

Also from *Cupressus goveniana,* southern part of Lake County; *Cupressus macnabiana* near Shasta postoffice, Shasta County; *Cupressus macrocarpa* at Pasadena; *Libocedrus decurrens,* Scott Valley, Siskiyou County; *Sequoia sempervirens* near Stanford University.

Authentication. Specimens compared with the type by Mr. Morrison.

Notes: This name has ordinarily been employed for the species which must stand as *P. sequoiae* (Coleman). Mr. Morrison's comparison of specimens with the type, together with the fact that the specimens seen by me in life agree with the original description, seems to establish the identity of the species satisfactorily. The types of *P. dudleyi* (Coleman) and *P. andersoni* (Coleman) are at hand and I can see no basis for separating them.

This species is near *P. sequoiae* (Coleman), but is distinguishable in life by the rather long caudal tassels and in preparations by the clustered pores of the anal lobe cerarii.

Pseudococcus salinus Ckll.

Plate 1, fig. 5.

1896. *Dactylopius salinus* Cockerell, Ann. Mag. Nat. Hist., (7), 9:21.

In life. "Grey, with some white secretion, six caudal tassels and two cephalic ones." (Ckll. 1896.) Found on the upper side of the leaf blades of the host.

Morphological characteristics. Apparently not more than 11 pairs of cerarii present, four of these being on the head and seven at the posterior end of the body. In the posterior seven pairs the cerarian spines of the anal lobe pair are the largest, the others becoming successively smaller anteriorly. First two cephalic pairs with three spines, the remainder with but two. Anal lobe pair with a group of rather numerous pores, the remainder with fewer. Auxiliary setae present in conjunction with the last two pairs only. Dorsal body setae very few, small, slender. Triangular pores quite numerous, mingled with a few large tubular ducts with rim about the mouth. Anal ring very weakly chitinized, simple except for the posterior half which is weakly chitinized and shows faint indications of the usual cellular structure. Due to the chitinization of the end of the alimentary canal, the ring usually presents a distinctly crescentic appearance. The position of the ring is quite unique, inasmuch as it lies behind the anal lobe cerarii and in all of the numerous specimens examined by me appears on the ventral side of the abdomen when the specimens are flattened out on the slide. Anal lobe and anal ring setae all noticeably short, the former about half the length of the latter.

Type host and locality. From grass (probably *Distichlis*) on the cliffs at La Jolla, Calif.

Hosts and distribution. From *Distichlis spicata* in the salt marshes at Palo Alto. Probably occurs throughout the range of this host at least.

Authentication. Specimens compared with the type material by Mr. Morrison.

Notes: I have examined specimens (from Essig collection) collected at La Jolla and determined by Cockerell as *P. salinus,* but which are evidently not *P. salinus,* belonging instead to the species herein described as *Trionymus distichlii* n. sp. The most striking features of *P. salinus* and those which at once separate it from any other are the almost simple anal ring, the extremely short anal lobe and anal ring setae, and the fact that the anal ring is borne upon the ventral side of the abdomen instead of on the dorsal side.

Pseudococcus sequoiae (Coleman).

Plate 1, fig. 3.

1901. *Dactylopius sequoiae* Coleman, Proc. Calif. Acad. Sci., (3), **2**:410-418, pl. 27. (As to the female.)

1910. *Pseudococcus ryani* (Coq.); Essig, Ponoma Col. Jn. Ent. **2**:148, fig. 61. (Not of Coquillet.)

In life. Thinly covered with powdery secretion, the lateral and caudal tassels practically lacking. Oviparous, the eggs placed in a very long, slender and somewhat fluted ovisac.

Morphological characteristics. With 17 pairs of cerarii the first three or four pairs with 3 spines, the remainder with but 2, all very small, those of the anal lobe pair somewhat the largest. The lateral cerarii without auxiliary setae and without grouped pores, so obscure as to be distinguishable only with difficulty in the adults. Anal lobe pair with three or four slender setae, the base of each of these and of each of the conical spines being surrounded by a little chitinous ring; with very few pores, these not grouped. Ventral side of the anal lobes without chitinized area. Dorsal body setae few, very small. Triangular pores few. Small cylindrical ducts without a raised rim about the mouth extremely abundant, especially at the lateral margins of the body. Anal lobe setae somewhat shorter than anal ring setae, accompanied by two very small minor setae.

Immature female differing but little from adult.

Type host and locality. From *Sequoia sempervirens,* near Stanford University.

Hosts and distribution. On *Cupressus macrocarpa* throughout the bay region, at Santa Cruz and at Cypress Point near Monterey. From *Sequoia sempervirens* near Stanford University. There appears to be but one generation a year, this, in the vicinity of Stanford, maturing early in June.

Authentication. Types examined.

Notes: An examination of the types of *Pseudococcus sequoiae* (Colem.) in the Stanford collection shows that this species was based upon the male of a species of *Puto* and the female of a species of *Pseudococcus*. As this male was later redescribed by Coleman under the name of *Pseudococcus cupressi* the name *sequoiae* must be retained for the female of the original description. This is the species which has ordinarily passed as *P. ryani* (Coq.), but that name appears rightfully to belong to another species.

Pseudococcus timberlakei Ckll.

Plate 2, fig. 19.

1916. *Pseudococcus timberlakei* Ckll., Jn. Econ. Ent. 9:312.

In life. "The lateral and caudal secretions of the active females closely resemble those of *Pseudococcus citrophilus* Claussen, figured on page 20, Calif. Exp. Sta. Bull. 258" (Timberlake's notes, quoted by Cockerell).

Morphological characteristics. With 17 pairs of cerarii, all with but two cerarian spines which are quite small except in the anal lobe cerarii in which the spines are large and stout. Lateral cerarii with few or no grouped pores and, except for the posterior one or two pairs, without auxiliary setae. Anal lobe cerarii surrounded by a conspicuous definite chitinized area bearing numerous long setae and many scattered pores. Ventral side of anal lobes with a small irregular chitinized area. Dorsal body setae numerous, quite long and slender. Triangular pores very few. Dorsum with many small cylindrical ducts without a raised rim about the mouth. Anal lobe setae and anal ring setae about equal, quite long. Anal ring of the usual type.

Type host and locality. From "salt marsh grass" (probably *Distichlis spicata*) at Milbrae, San Mateo County, Calif., October.

Hosts and distribution. Known only from the San Francisco Bay region. I have taken it from *Distichlis spicata* in the salt marshes at Palo Alto.

Authentication. Specimen compared with type by Mr. Morrison.

Notes: This differs markedly from *P. salinus* (Ckll.) which occurs upon the same host, the well developed anal ring alone being sufficient to distinguish it from that species. It really most nearly resembles *Trionymus californicus* Ehrh. although the two are regarded as generically separate because of the difference in the number of cerarii. A further discussion of this resemblance will be found under the description of *T. californicus*. The species appears to be rather rare, at least much more so than either *P. salinus* (Ckll.) and *Trionymus distichlii* n. sp., which are found with it. Like these species, there is but a single brood, which matures in September or October.

Genus **PHENACOCCUS** Cockerell.

Pseudococcine forms with not less than 18 pairs of cerarii; with a denticle on the inner face of the tarsal claw; with normally 9-segmented antennae, although sometimes with 8 segments. Without a continuous series of chitinized areas about the margin of the body. Male as in *Pseudococcus*. Dermal pores of the triangular type present.

Type of the genus *P. aceris* (Sign.).

I have before me specimens determined by E. E. Green as *P. aceris* (Sign.). These, together with the excellent redescription of this species given by Marchal (7), permit somewhat more definite conclusions as to the nature of the genus than does the original description given by Cockerell, who merely stated that the genus consists of forms with female having "9-segmented antennae and secreting an ovisac."

The presence of 18 pairs of cerarii appears to be quite constant and quite characteristic of the group. In some cases the cerarii are difficult to count, due to the small size of the spines, but it is usually possible to determine their number with sufficient surety from the immature stages. In the case of an apparently undescribed species on beech in Canada this number is increased to as high as 24 by the development of what may be called secondary cerarii, but I am inclined to believe that the immature stages of this species would show the normal number. I consider that such species as *Phenacoccus mangiferae* Green cannot be regarded as congeneric with *P. aceris*.

The genus *Tylococcus* Newstead was based entirely upon the fact that the cerarii in the type species are elevated upon prominent tubercles and according to the original definition of this genus and the later characterization of it by Brain, certain species included by me in *Phenacoccus* should be referred to *Tylococcus*. However, I do not believe that the genus is tenable on the basis of this character alone, for I have observed that there is often a tendency for the cerarii to be more or less prominent in the immature stages and in *Phenacoccus artemisiae* Ehrh. they are borne upon very prominent tubercles which entirely disappear in the adult. In the case of the undescribed species from beech, of which I have spoken above, the tubercles persist in the adult female.

The genus as I have defined it here appears to be a perfectly natural group, although doubtless the examination of more species will disturb this apparent harmony. Some species are included in which the specific characters are extremely obscure and I anticipate that the separation of any considerable series of species will be attended by much difficulty.

KEY TO SPECIES OCCURRING IN CALIFORNIA

1. With numerous very large tubular ducts, the mouths of which are borne at the apices of prominent, conical projections . . . . . *stachyos* Ehrh.
   Without such ducts 2
2. Ducts very short and stout . . . . . *kuwanae,* Colem.
   Ducts not so 3
3. Anal lobe cerarii with as many as 8-10 cerarian spines . . . . . *eriogoni* n. sp.
   Anal lobe cerarii with at the most 3-4 cerarian spines 4
4. Anal lobes prominent, with the cerarian spines borne at their tip . . . . . *artemisiae* Ehrh.
   Anal lobe cerarii with at the most 3-4 cerarian spines 4
   borne on the dorsum 5
5. Antennae of the adult female 9-segmented . . . . . *colemani* Ehrh.
   Antennae of the adult female 8-segmented . *solani* n. sp.

Phenacoccus artemisiae Ehrh.

Plate 2, fig. 15.

1900. *Phenacoccus artemisiae* Ehrhorn, Can. Ent. **32**:313.

In life. Very slightly dusted over with waxy powder, without noticeable lateral or caudal tassels. Oviparous, the ovisac firm, quite long and slender. On the leaves and small twigs of the host.

Morphological characteristics. First three or four pairs of cerarii with three to four spines, the remainder with but two, all without auxiliary setae. In all, the spines are quite small and are associated with but two or three grouped pores, the cerarii being so obscure that they are difficult to trace along the lateral margins in the mature insect. Conical spines of the anal lobe cerarii borne at the tip of the prominent, teat-like anal lobes, associated with no auxiliary setae and with no especially grouped pores and with but the slightest indication of chitinization. Dorsal body setae extremely minute and very few in number. Triangular pores scattered sparingly over the body, mingled with a few tubular ducts without a raised rim about the mouth. Anal lobe setae perhaps slightly shorter than the anal ring setae.

Immature female very much resembling the mature female except that the cerarii of the anterior half of the body are borne at the tips of prominent tubercles.

Type host and locality. From *Artemisia californica,* Stevens Creek, Santa Clara County, Calif.

Hosts and distribution. Essig has recorded this species from the type host in Ventura County. Otherwise it is known only from the original locality. It very probably occurs throughout the range of this host, at least.

Authentication. Specimens from type host and locality, agreeing with original description.

Notes: The only really distinctive feature of this species is the curiously prominent character of the anal lobes. In some species the anal lobes are more or less prominent in immature individuals, this prominence disappearing in the adult, but in *P. artemisiae* the prominence remains. Otherwise the species is scarcely distinguishable from *P. colemani.*

Phenacoccus colemani Ehrh.

Plate 2, fig. 20.

1906. *Phenacoccus colemani* Ehrhorn, Can. Ent. **38**:332-3.

In life. Thinly dusted with waxy powder, without noticeable lateral or caudal tassels. Oviparous, the eggs laid in a very loose, fluffy ovisac. The species is scarcely, if at all, distinguishable in life from *Phenacoccus solani* n. sp., although structurally they are sufficiently distinct.

Morphological characteristics. First three or four pairs of cerarii with three or four conical spines, the remainder with but two, except for the anal lobe pair, in which there may be as many as four. In all, the spines are quite small, slender, sharply pointed and somewhat constricted at the base. In the typical form the anal lobe cerarii have but two conical spines which are accompanied by three or four very small spines. This form, however, grades over into another in which one or two of the small spines are equal to the larger in size, and into another form in which the small spines are replaced by a single stiff seta. In all the cerarii there are but few pores, and no auxiliary setae. Dorsal body setae very few and scattered, small, more or less conical, not constricted at the base. Triangular pores few, mingled with a few tubular ducts. Anal lobe setae nearly twice as long as anal ring setae.

Immature female differing but little from the adult.

Type host and locality. From *Rubus* sp., Pescadero road, south of Palo Alto, Santa Clara County, Calif.

Hosts and distribution. I have taken this from *Rubus vitifolius,* wild strawberries, *Symphoricarpos racemosus, Castilleia* sp. *Eriophyllum confertiflorum* and from beneath a rock, associated with ants, in the hills near Stanford University. Mr. Swain has sent me specimens from geranium at Riverside.

Authentication. Specimens from type host and locality, agreeing in general with the original description.

Notes: I am by no means certain that all the forms referred by me to this species are rightly placed. The extreme forms observed are sufficiently different to arouse doubt, yet there appears to be an almost perfect gradation between these and I can find no real basis upon which to effect a separation.

Phenacoccus eriogoni n. sp.

Plate 2, fig. 14.

In life. Thickly covered with white wax, the lateral tassels short and broad, the caudal tassels somewhat longer. Ovisac not observed.

Morphological characteristics. All the cerarii with more than two cerarian spines, the anal lobe pair having as many as ten, the remainder three to six, these spines slender, sharply pointed and slightly constricted at the base; no auxiliary setae. Pores of the cerarii scarcely exceeding the spines in number and not at all concentrated. The anal lobe and penultimate cerarii show more or less of a tendency toward the development of a chitinized area, which is, however, never well defined. Ventral sides of the anal lobes without chitinized area. Dorsal body setae almost lacking, the few that are present being extremely minute. Triangular pores numerous, mingled with a few large tubular ducts with raised rim about the mouth. Anal lobe setae equal to or a trifle shorter than the anal ring setae.

Immature female not differing materially from the adult.

Type host and locality. From crowns and stems of *Eriogonum nudum,* Stevens Creek, Santa Clara County, Calif.

Host and distribution. Known only from the above host and locality. It is common enough in this vicinity.

This is quite distinct from any other species seen by me, and I cannot connect it with any described form.

Phenacoccus kuwanae Coleman.

1903. *Phénacoccus kuwanae* Coleman, Jn. N. Y. Ent. Soc. **11**:62, pl. 5, figs. 1-2.

In life. "Length 1.6 mm.; color yellowish-white; body sparsely covered with a yellowish-white powder; . . ." With ovisac, "length about 2.5 mm.; ovisac yellowish-white, short, oblong, smooth." (Coleman.)

Type host and locality. "On a species of lichen growing on the weeping spruce, *Picea breweriana,* on the east side near the summit of the Salmon Mountains, about ten miles west of Salmon Forks, Siskiyou County, Calif., August 3, 1901."

Hosts and distribution. Known only as above.

Notes: The types of this species are in the Stanford collection, but are in such bad condition that it is impossible to base a redescription upon them. The original description contains nothing that will give any particular aid in recognizing the species. The only distinctive feature that the types reveal is the presence of many short, stout, cylindrical ducts. In this character the species is evidently very similar to *P. piceae* (Loew) which has been redescribed by Marchal (7, pp. 243-5, figs. 11-12). It is entirely possible that they are identical.

Phenacoccus stachyos Ehrhorn.

Plate 2, figs. 17, 22.

1900. *Phenacoccus stachyos* Ehrhorn, Can. Ent. **32**:313.
1904. *Phenacoccus osborni* Sanders, Ohio Nat. **2**:284.
1912. (?) *Heliococcus bohemicus* Sulc, Čas. společ. Ent. **9**:39, figs.
1917. *Phenacoccus pettiti* Hollinger, Can. Ent. **49**:281, fig.
1918. *Phenacoccus stachyos* Ehrh.; Hollinger, Ibid. **50**:23.

In life. Covered with mealy secretion from which there arise many delicate, glassy threads of wax. Lateral and caudal tassels very short. Oviparous, not forming a definite ovisac.

Morphological characteristics. Ocular cerarii with three or four cerarian spines, the remainder with but two, all small and slender, those of the anal lobe pair but little larger than most of the others. No auxiliary setae and practically no concentration of pores about the cerarian spines. Spines of the anal lobe pair borne at the extreme tips of the quite prominent anal lobes. Ventral side of the anal lobes usually with a small chitinized area extending in from the base of the anal lobe setae. Dorsal body setae few, extremely small. Ventral setae long and slender. Triangular pores few. Tubular ducts of a very peculiar type, many of them extraordinarily large and all with their mouths borne at the apices of conical prominences, about the base of which there may be from one to four small spines. The base of many of these projections is surrounded by a small circular, chitinized area. These ducts appear to have a rather definite arrangement, there being from two to four on each anal lobe, two or three near each cerarius, an indefinite number on the head and an irregular double row along the median line of the body. It is from these ducts that the long, glassy threads of wax arise. Anal lobe setae about one and one-half times as long as the anal ring setae. Antennae noticeably long and slender.

Immature specimens differing from the adult chiefly in a reduction of the number of ducts.

Type host and locality. From *Stachys bullata,* San Franciscquito Creek, near Stanford University, California.

Hosts and distribution. I have this species from *Stachys* sp., Woodside, San Mateo County, and Big Basin, Santa Cruz County: *Monardella* sp.,

Big Basin; *Diplacus glutinosus,* Woodside; *Solanum* sp., Permanente Creek, Santa Clara County; *Toxicodendron* (*Rhus*) *diversiloba,* Stevens Creek and Corte Madera Creek, Santa Clara County. In the Stanford collection from *Catalpa* at Columbus, Ohio. Recorded by Hollinger (as *Phenacoccus pettiti*) from numerous hosts in Missouri and by Sanders (as *Phenacoccus osborni*) from sycamore at Columbus, Ohio. What is possibly the same species has been described by Sulc as *Heliococcus bohemicus* from *Robinia pseudacacia* in Bohemia and Moravia.

Authentication. Specimens from the type host and locality agreeing with the original description.

Notes: This is one of the most distinctive species of the genus. Mr. Morrison has kindly furnished me with copies of the figures accompanying the original description of *Heliococcus bohemicus* Sulc and these leave no doubt that this species is extremely close to *P. stachyos,* if it be not the same. It is worthy of note that *Robinia pseudacacia* is a native of Eastern North America, where *Phenacoccus stachyos* appears to be quite common. Mr. Morrison also informs me that *Phenacoccus osborni* Sanders appears to be the same.

I do not for the present accept the genus *Heliococcus.* The genus can be maintained only on the basis of the peculiar ducts, for it is in all other respects not different from typical *Phenacoccus.* On this basis *Pseudococcus virgatus* (which is indeed not a *Pseudococcus*) would be included in *Heliococcus,* although it does not belong to the *Phenacoccus* series. Until the group is better understood it may be well to maintain the present arrangement.

Phenacoccus solani new species.

Plate 2, fig. 21.

1914. *Pseudococcus solani* Ckll.; Essig, Mon. Bull. State Com. Hort. **3**, No. 3:122, fig. 35. (Misidentification?)

In life. Dusted with powdery secretion, with no lateral or caudal tassels. Ovisac not known.

Morphological characteristics. Antennae 8-segmented in the adult female. Tooth of the tarsal claws usually very small. None of the cerarii with more than two conical spines, these, in all the cerarii, small, sharply pointed, accompanied by no auxiliary setae and by but the slightest grouping of the pores, the cerarii being so obscure that in the adult it is only with difficulty they can be traced. Anal lobe cerarii sometimes with a single small hair, sometimes with two or three very small spines in addition to the cerarian spines; borne upon the dorsal surface of the anal lobes. No chitinization either dorsally or ventrally. Dorsal body setae small, sharply pointed, of a characteristic lanceolate shape. Triangular pores numerous, accompanied by a very few cylindrical ducts without a raised rim about the mouth. Anal lobe setae about one and one-half times as long as the anal ring setae.

Immature female in general resembling the adult.

Type host and locality. From roots of *Hemizonia rudis* (tarweed) on the campus of Stanford University.

Hosts and distribution. I have this from potato, tomato and wild radish in the vicinity of Stanford University, potato and *Malva* sp. from near San Jose and immature specimens that I believe to be this species, from roots of pansies at Salt Lake (R. W. Doane, coll.). Specimens are in Mr. Essig's collection from *Malva rotundifolia* and *Malva parviflora,* in Ventura County. Recorded by Essig from these hosts and from potato, tomato, wild sunflower, *Aster,* nightshade and purslane from southern California and from potatoes at Stockton.

Notes: In spite of the 8-segmented antennae this is certainly a *Phenacoccus,* although the generic characters are indeed obscure. The determination of this as *Pseudococcus solani* Ckll., which was described from New Mexico, seems to have been made upon the basis of the fact that both have been found upon potatoes. It is entirely possible that this determination is correct, but it is equally possible that it is not, and I am describing the species as new, keeping the name *solani* in order that no change will be necessary if this determination is confirmed.

In life this might, perhaps, be confused with *Pseudococcus eriogoni* (Ehrh.) which it greatly resembles both in appearance and habitat. In preparations it much more nearly resembles *Pseudococcus* than *Phenacoccus,* but the presence of 18 pairs of cerarii and of a denticle on the claws will place it in the latter group.

Phenacoccus simplex King.

1902. *Phenacoccus simplex* King, Ent. News. 13:42-3.

In life. Oval in shape, 3 mm. long, 2 broad, of a reddish-brown color. Body thinly covered with white secretion" (King).

Morphological characteristics. The only information of any value conveyed by the original description is as follows: "Boiled in KOH, cleared and mounted in balsam, practically colorless except around the area of the grouped spines, which is tinged with yellowish-brown. These groups are variable in size and the spines are conical in shape, short, stout and placed close together. The dorsum is quite thickly beset with short conical spines and thin, not at all long, hairs. These not uniform in length."

Type host and locality. Lone Pine, California. On *Atriplex.*

Notes: I have not seen this species. The description conveys a faint hint that this may be a *Puto,* but beyond this little can be said.

Genus **PUTO** Signoret

1875. *Puto* Signoret, Ann. Soc. Ent. Fr., (5), 5:394.
1897. *Ceroputo* Sulc, Sitz. k. Bohm. Ges. Wiss., no. 61.

Pseudococcine forms with a tooth on the face of the tarsal claws and with all the cerarii (from 16 to 18 pairs) surrounded by a definite

chitinized area and including numerous conical spines. Antennae of the adult female 8- or 9-segmented. Anal ring with 6 to 8 hairs. Male larvae resembling those of the female in all respects up to the time of pupation. Adult males apterous or alate, extraordinarily large, with a wing expanse of as much as 8 mm. and a body of 5 mm. Type of the genus *Puto antennata* Sign.

I consider *Ceroputo* to be strictly a synonym of *Puto*. The former genus was separated from the latter solely on the basis of the presence of but six hairs on the anal ring and of non-clubbed digitules. The description of the type species of *Ceroputo* is extremely minute, and the author of the genus also redescribes *Puto antennata* from the type specimens. Of the species herein dealt with, *P. cupressi* (Coleman), except for the 8-segmented antennae, would ordinarily be referred to *Puto,* while the remainder would be referred to *Ceroputo,* but I cannot consider the differences to be sufficient to justify a generic separation, especially in view of the close resemblance in other respects.

It may be noted that Brain (2) has quite thoroughly misunderstood this genus and has placed it among the Eriococcine forms solely because of the 8-haired anal ring. The species which he has described as *P. africanus* undoubtedly does not belong to this genus.

The males of this genus are very different from the males of *Pseudococcus* and the other genera herein dealt with. Until the formation of the cocoon they differ in no respect from the larvae of the females, and they are also notable for their large size. In the case of *P. ambigua* (Full.) they are said to be apterous, while in other species they are alate.

But three species are known from California. These may be distinguished by the following key.

1. Antennae of the adult female 8-segmented, anal ring of the adult female with 8 setae . . . *cupressi* (Coleman)
   Antennae of adult female 9-segmented; anal ring of all stages with 6 setae 2
2. Adult male winged . . . . . *yuccae* (Coq.)
   Adult male apterous . . . . . *ambigua* (Full.)

Puto ambigua (Fullaway).

1910. *Ceroputo ambigua* Fullaway, Proc. Davenport Acad. Sci. **12**:233.

This species resembles *P. yuccae* (Coq.) in every respect except in the fact that the males are apterous. There is the possibility that both apterous and alate males are produced (as is the case with *Gossyparia spuria*) and should this prove to be true, the species may be dropped.

Type host and locality. From *Salicornia ambigua,* salt marshes at Palo Alto, Calif.

Hosts and distribution. Known only from the above host and locality.

Authentication. Topotype specimens examined.

Puto cupressi (Coleman).

1901. *Dactylopius sequoiae* Coleman, Proc. Calif. Acad. Sci., (3), **2**:410, fig. (As to male.)

1908. *Pseudococcus cupressi* Coleman, Jn. N. Y. Ent. Soc. **16**:197-8, pl. 4, figs. 1-4.

In life. Adult female reaching the length of 6 mm.; dorsally bare of secretion except for a dusting of fine powder; with very short, stout, lateral tassels and with a somewhat longer caudal pair. Dorsum of a light brown color, with marginal and submedian longitudinal rows of dark spots. Ovisac more or less pad-like. Oviparous.

Morphological characteristics. Adult female with 8-segmented antennae. The fundamental arrangement of 18 pairs of cerarii (indicated in the first stage larva) is obscured by the presence of small secondary cerarii and occasionally by the more or less complete suppression of certain of the cerarii. Chitinous areas surrounding the cerarii for the most part rather small, the number of cerarian spines ranging from 5-12, the anal lobe area being much larger than any of the others and being continuous with a small chitinized area on the ventral side of the anal lobes. Dorsum with few spines, these short and conical. Anal ring with 8 hairs (in the adult), one pair of these being considerably smaller than the others.

Immature female with 7-segmented antennae and with the chitinized areas of the cerarii smaller than in the adult. The first stage larva possesses 7-segmented antennae. In all the immature stages of both male and female I find but six anal ring setae. The male prepupa is enclosed in a conspicuous white sac.

Adult male winged, with a wing expanse of 8 mm., of the type usual to the genus.

Type host and locality. From *Cupressus macrocarpa,* Cypress Point, Monterey County, Calif.

Hosts and distribution. From *Pinus radiata,* Pacific Grove; *Torreya californica,* Stevens Creek, Santa Clara County (Ehrhorn, coll.); *Sequoia sempervirens,* vicinity Stanford University. At Pacific Grove and Cypress Point the species becomes mature in December and January, in the vicinity of Stanford University adult females are not found until May and June.

Authentication. Cotype and topotype specimens examined, the former through the courtesy of Mr. Ehrhorn.

Notes: It has been proven beyond any room for doubt that the male described by Coleman under *Dactylopius sequoiae* does not belong with the female of that species. Neither is there any doubt that this male is the same as that described by the same author under *Pseudococcus cupressi.* This species is of much interest, inasmuch as it effectually unites the two genera *Puto* and *Ceroputo.*

Puto yuccae (Coq.).

1889. *Dactylopius crawii* Coquillet, West Amer. Sci. **6**:123. (As to male.)
1890. *Dactylopius yuccae* Coquillet, West Amer. Sci. **7**:44.
1896. *Phenacoccus yuccae* (Coq.); Cockerell, Check List of Coccidae.
1900. *Phenacoccus bahiae* Ehrhorn, Can. Ent. **32**:315.
1901. *Ceroputo yuccae* (Coq.); Cockerell, Proc. Biol. Soc. Wash. **14**:166.
1901. *Ceroputo bahiae* (Ehrh.); Cockerell, Can. Ent. **33**:166.
1903. *Ceroputo yuccae* var. *ceanothi* Ckll., Ann. Mag. Nat. Hist., (7), **11**:163.
1912. *Phenacoccus ramonae* Essig, Pomona Col. Jn. Ent. **1**:26, fig.
1912. *Ceroputo yuccae* (Coq.); Essig, Pomona Col. Jn. Ent. **1**:94, fig. 43.
1913. *Ceroputo yuccae* (Coq.); Essig, Mon. Bull. Calif. State Com. Hort. **2**:95, fig. 74.

In life. Thickly covered with white wax; with short, stout lateral tassels, the caudal tassels being somewhat longer. Length 4-6 mm. Male pupa contained in a white cocoon of 3-4 mm. length. Adult male winged, with a wing expanse of 7-8 mm. and with a pair of caudal wax tassels as much as 6 mm. long.

Morphological characteristics. Antennae of the adult female 9-segmented. Antennae and legs strongly chitinous. Cerarii varying in number from 15 to 18, each surrounded by a chitinous area, each containing a dozen or more short, conical spines and a somewhat smaller number of pores. Anal lobe area largest. No chitinized area on the ventral side of the anal lobes. Dorsum with small, scattered, conical spines. Anal ring with six setae, very rarely with eight.

Immature female resembling the adult except for the smaller size of the chitinized areas. First stage larva with 7-segmented antennae.

Type host and locality. From *Yucca whipplei,* Los Angeles County, Calif.

Hosts and distribution. Recorded from several species of yucca, from *Diplacus glutinosus, Ramona polystachya,* citrus and bananas in the southern part of the state. In the vicinity of Stanford University I have taken the species from *Eriophyllum confertiflorum, Diplacus glutinosus, Garrya elliptica* and *Stachys* sp.

Authentication. Not authenticated. Specimens from the type region have been examined which agree with the original description and which belong to a species that has generally been accepted as *P. yuccae* (Coq.).

Notes: I have examined topotypic specimens of *Ceroputo bahiae* (Ehrh.) and can find no basis upon which to separate this from *Puto yuccae.* The variety

ceanothi, established by Cockerell because of the "considerably longer second and fourth joints of the antennae," is hardly to be taken seriously. Among the material of *Pseudococcus agrifoliae* received from Mr. Essig is a slide labeled "cotype" which contains specimens of larvae of a *Puto* taken from *Quercus agrifolia* near Claremont. It is impossible to identify these specimens with certainty, but it is possible that these are *P. yuccae.*

Genus **HETEROCOCCUS** new genus

Pseudococcine forms with quinquelocular dorsal pores instead of the usual triangular pores; with cerarii on the posterior portion of the abdomen only; with a more or less distinct denticle on the tarsal claws; with 9-segmented antennae in the adult female.

Type of the genus *Heterococcus arenae* n. sp.

Notes: Morphologically the species upon which this genus is based seems to belong to the *Phenacoccus* series, the 9-segmented antennae and the presence of a denticle on the claw being indicative of this. However, the presence of circular dorsal pores is quite distinctive. It is possible that *Pseudococcus poae* (Maskell) is congeneric with this, for it is said in the original description of that species that "All over the body are small circular spinnerets." Otherwise I know of no similar species.

Heterococcus arenae n. sp.

Text figure 16C; plate 3, fig. 32.

In life. Found beneath the leaf sheaths of its host, where it is surrounded by a small amount of secretion.

Morphological characteristics. Cerarii present on the last two abdominal segments only; each with two slender and rather long spines which are distinguishable from the body spines only by their position and paired character; without grouped pores. Anal lobe cerarii accompanied by a few spines which are as large as the cerarian spines. Dorsal body setae slender, scattered, ventral body setae few, slender. Dorsum with numerous pores, all of which are circular and quite large. Tubular ducts few and very small, all without a raised rim about the mouth. Tarsal claws typically with a denticle, although in some specimens this appears to be lacking. Anal ring large. Anal lobe setae slightly longer than the anal ring setae. Antennae of the adult female 9-segmented.

Immature female differing from adult only in reduction of number of antennal segments.

Type host and locality. From *Poa douglasii,* on the sand dunes near Asilomar at Pacific Grove, Monterey County, Calif., December 1, 1917.

Hosts and distribution. Known only from above host and locality.

Genus **TRIONYMUS** Berg

Pseudococcine forms with normally not more than three or four pairs of cerarii, these on the posterior portion of the abdomen. Derm never pigmented. Dorsal body setae never conical or "spearhead-shaped." Dermal pores of the triangular type present. Dorsum frequently with many multilocular pores. Claw without a denticle. Antennae of the adult female 7- or 8-segmented.

Type of the genus, *Trionymus perrisi* (Sign.).

Notes: The type species of this genus has been well described by Marchal (7) and its nature is sufficiently clear. It is evidently very similar to *T. californicus* Ehrh. The genus was originally established chiefly upon the elongated form of the female, but this can hardly be considered sufficient. If the genus be maintained at all it must be on the basis of the reduced number of pairs of cerarii, and such an interpretation will necessitate its extension to include several species now referred to the genus *Ripersia*. I cannot believe that such species as *Trionymus bromi* n. sp. and *Ripersia festucae* Kuwana should be separated generically simply because of the difference of a single segment in the antennae, nor, if this interpretation be accepted, can I at present see any way by which such species as *Ripersia villosa* Ehrh. or *Pseudococcus trifolii* (Forbes) can be kept out of this genus.

As a matter of fact such a step, even though it result in creating a somewhat unnatural group, can produce no worse confusion than that at present displayed in the genus *Ripersia*. The real nature of this genus cannot be determined, for it was originally based simply upon the 6-segmented antennae of the adult female of the type species and this is practically the only significant fact that we possess in regard to this species. As at present understood the genus is made to include almost any species with 7-segmented antennae occurring on grass, roots or with ants. Even though the descriptions of practically every one of the North American species are hopelessly inadequate, it is obvious that the group thus obtained is a most heterogeneous assemblage and is for all practical purposes meaningless.

KEY TO CALIFORNIA SPECIES.

1. With but one pair of cerarii, these on anal lobes 4
   With at least two pairs of cerarii 2
2. Anal lobe cerarii surrounded by a chitinized area bearing numerous pores and setae . . . *californicus* Ehrh.
   Anal lobe cerarii not so 3
3. Antennae of adult female 8-segmented *calceolariae* (Mask.)
   Antennae of adult female 7-segmented *festucae* (Kuwana)
4. Cerarian spines setiform . . . . . *distichlii* n. sp.
   Cerarian spines conical 5
5. Cerarii without grouped pores 6
   Cerarii with numerous pores . . . . *grindeliae* n. sp.

6. Dorsum with short, broad, tubular ducts . *villosa* (Ehrh.)
   Dorsum without such ducts 7
7. Anal ring setae scarcely more than one-half the length of the anal lobe setae; antennae of adult female 7-segmented . . . . . *smithii* (Essig)
   Anal ring setae equaling anal lobe setae; antennae of adult female 8-segmented . . . . . *bromi* n. sp.

Trionymus bromi new species.

In life. Either in the axils or on the upper surface of the leaves. Surrounded by a fluffy mass of cotton.

Morphological characteristics. Antennae of the adult female 8-segmented. But one pair of cerarii present, these on the anal lobes and containing two short, sharp spines, two or three small setae and a very few pores. Body setae few, inconspicuous, short, slender, curved. Body with many triangular pores and small tubular ducts, and with a few multilocular pores on the dorsum of the abdomen. Anal lobe setae but little if any longer than the anal ring setae. Anal ring rather small and heavily chitinized.

Immature female not observed.

Type host and locality. From *Bromus* sp. Corte Madera Creek near Stanford University, Calif.

Hosts and distribution. From the same host on the road above Congress Springs, Santa Clara County; from *Ammophila arenaria* on the sand dunes near Golden Gate Park, San Francisco; from the bark of *Ericameria fasciculata* (a composite) on the sand dunes near Pacific Grove, Monterey County.

Notes: This is quite abundant locally. I have but little doubt that it is a described species, yet I can connect it with none and must give it a name. The specimens taken from *Ericameria* had in all probability merely entered the crevices of the loose bark in order to form their ovisacs and it is improbable that the species feeds on this host.

Trionymus calceolariae (Maskell).

1878. *Dactylopius calceolariae* Maskell, Trans. New Zealand Inst. 11:218.

In life. Concealed beneath the sheathing bases of the leaves of its host, surrounded by masses of wax.

Morphological characteristics. Antennae of the adult female 8-segmented. Two pairs of cerarii present, the cerarian spines short, stout, conical, not accompanied by grouped pores or auxiliary setae. Entire body beset with many short hairs, of about equal length on dorsal and ventral sides. Derm with many triangular pores and small tubular ducts

without a raised rim about the mouth. Large numbers of multilocular pores present on the dorsum of the abdomen as well as on the venter. Anal ring hairs slightly shorter and more slender than the anal lobe hairs. Anal ring large and heavily chitinized.

Immature female much resembling the adult.

Type host and locality. From *Calceolaria* in Australia.

Hosts and distribution. As far as I am aware this species is known only from "New Zealand flax" on the campus at Berkeley.

Authentication. Not authenticated. Is probably not the *Dactylopius calceolariae* of Maskell.

Notes: Specimens from Berkeley have been compared by Mr. Morrison with specimens in the Maskell collection at Washington and he has furnished the following information: "We do not appear to have the type slides of *calceolariae,* as that was described in 1878, and the first slide in the Maskell collection is dated 1880. However, your specimen appears to agree exactly with the one in the Maskell collection. There are also two other specimens, about 1887, in the Maskell collection which have three cerari on each side at the apex of the abdomen, instead of two as have your specimens and the first one in the Maskell collection. In all other respects they seem to be the same as the earlier specimens. I find that the same situation exists in the Department collection as well, there being two groups of specimens, one with three pairs of cerari and one with two."

It is possible that these are the same species, for a similar variation occurs in *T. californicus* Ehrh., but it is equally possible that two species are included. In either case I can scarcely believe that the species at hand is the real *Dactylopius calceolariae* of Maskell. In the original description it is stated that "the appendages are short except at the posterior end, where there are two very long, and, on each side of them, another somewhat shorter," and the species is figured with caudal tassels of nearly half the length of the body. In the specimens before me there cannot possibly be any lateral tassels because of the entire absence of cerarii and the weak development of the anal and preanal cerarii precludes the development of any but the shortest tassels in this region. There is therefore every possibility that Maskell himself has confused two or more species under this name, but toward the solution of this problem I can of course give no aid. For the present I am retaining the name for the specimens at hand rather than give a new name for a species which in all probability already is supplied with one.

Trionymus californicus Ehrhorn.

See plate 2, fig. 19.

1910. *Ripersia smithii* Essig, Pomona Col. Jn. Ent. **2**:219-221, fig. (In part.)
1911. *Trionymus californicus* Ehrhorn, Can. Ent. **43**:279, figs. 17, 1-1b.

In life. Found beneath the sheathing bases of the leaves, enclosed in more or less waxy secretion, or at times free upon the leaves. When found free upon the host there are two or three pairs of caudal tassels of which the last are quite stout and are nearly one-third the length of the body, the others smaller.

Morphological characteristics. Antennae 8-segmented. Two to four pairs of cerarii present at the posterior end of the abdomen, the cerarian spines of the anal lobe pair large and stout, of the penultimate pair somewhat smaller, of the third and fourth pairs more or less hairlike, usually indistinguishable from the body setae. Spines of the anal cerarii surrounded by a rather large chitinized area, containing numerous pores and bearing from 8-10 rather long hairs. Remaining cerarii with few pores and no hairs. Dorsum with numerous slender setae which are nearly or quite as long as those on the ventral side. Many triangular pores and many tubular ducts without a raised rim about the mouth. Dorsum with very few multilocular pores. Anal ring large and rather weakly chitinized, the anal ring hairs slightly longer than the anal lobe hairs.

Immature female differing from the adult chiefly in the smaller number of hairs and pores and the weaker development of the chitinized area about the anal cerarii.

Type host and locality. From grass at Lathrop, San Joaquin County, Calif.

Hosts and distribution. In Essig's collection from *Elymus condensatus,* Ventura County; in the Stanford collection from *Elymus* sp., Wenatchee, Wash.; *Elymus* sp., edge of the salt marshes at Palo Alto, Calif.; *Elymus* sp., at Pacific Grove, Monterey County, Calif.

Authentication. Cotype slide examined.

Notes: I am indebted to Mr. Ehrhorn for the loan of a cotype slide of *T. californicus* and to Mr. Essig for cotypes of *Ripersia smithii.* The slides labeled as *R. smithii* contain two species, of which one will stand as *Trionymus smithii* (Essig). The other is identical with *T. californicus,* which is very near to, if not identical with, specimens from Missouri that I have seen identified as *T. americanus* Ckll. *T. californicus* may possibly be a synonym of the latter.

The cotype of *T. californicus* examined by me has two pairs of cerarii, but the specimens from *Elymus* at Palo Alto show a tendency to the development of more. In several cases they show three pairs, in some four, and in one there are several cerarii on one side of the body. Otherwise these specimens are typical *californicus,* but further material may necessitate a separation. It should be noted that except for the reduction in the number of cerarii this species is very similar to *Pseudococcus timberlakei* Ckll., so much so in fact as to suggest a possibility that they should not be generically separated.

Trionymus distichlii n. sp.

Plate 3, fig. 28.

In life. Occurring either upon the upper side of the leaves or at their axils. Entirely covered by fluffy mass of wax. Insect of a purplish color when denuded of secretion.

Morphological characteristics. Antennae of the adult female 7-seg-

mented. But one pair of cerarii present, these on the anal lobes, the cerarian spines elongated and differing only in size from the body setae, accompanied by two or three slender hairs and no grouped pores. Body with relatively few pores and ducts. Dorsum of the abdomen with numbers of multilocular pores. Very few setae except on the last three or four segments of the abdomen, where there are many slender setae of about equal length on the dorsum and venter. Anal lobe setae slightly shorter than the anal ring setae. Anal ring rather weakly chitinized.

Type host and locality. Quite abundant at times on the salt marsh grass, *Distichlis spicata,* at Palo Alto, Calif.

Hosts and distribution. I have specimens from the type host at Ano Nuevo Point, Santa Cruz County and from La Jolla. In the vicinity of Palo Alto the species becomes mature in August and September.

Notes: This is distinguished chiefly by the elongated cerarian spines. I have specimens of this from La Jolla collected by Cockerell and determined by him as his *Pseudococcus salinus,* which they cannot possibly be, according to his original description of that species.

Trionymus festucae (Kuwana).

1902. *Ripersia festucae* Kuwana, Proc. Cal. Acad. Sci., (3), **3**:401, pl. 25, figs. 11-16.

In life. Concealed beneath the sheathing bases of the leaves, enclosed in more or less mealy secretion.

Morphological characteristics. Antennae 7-segmented. Two pairs of cerarii present, these on the last two segments of the abdomen, each containing two small, sharp, conical spines, not accompanied by grouped pores. Scattered about the anal cerarii are a few slender setae which do not appear to be especially connected with them. Dorsum of the abdomen with numerous multilocular pores. Body with short hairs dorsally and ventrally, these somewhat more numerous toward the posterior end, but not so strikingly so as in *T. smithii.* Setae of the anal ring quite long, slightly longer than those of the anal lobes. Anal ring rather small and heavily chitinized.

Immature female. The larva has 6-segmented antennae and but one pair of cerarii.

Type host and locality. From *Festuca* sp., on Black Mountain near Stanford University.

Hosts and distribution. I have taken this from *Festuca* sp., near Woodside, San Mateo County, Calif., and have also found a species on bamboo on the Stanford campus that I am unable to separate from it.

Authentication. Types examined.

Notes: I have seen specimens from Missouri that I believe to be identical with this species.

Trionymus grindeliae n. sp.

Plate 3, fig. 26.

In life. With a single pair of slender caudal tassels which attain perhaps the length of the body. A root-infesting form.

Morphological characteristics. Antennae 7-segmented in the adult female. With but one pair of cerarii, these on the anal lobes and containing two or three slender, conical spines, several smaller spines, or spines and slender setae, and a cluster of numerous and rather scattered pores. Dorsum with no multilocular pores. Dorsal body setae few, varying in size and shape from small and slender to quite large and stout, those near the margin of the next to the last abdominal segment being as large as the cerarian spines. Tubular ducts all very small, almost lacking on the dorsum, but abundant on the venter. Anal ring setae somewhat stouter and larger than the anal lobe setae.

Immature specimens not observed.

Type host and locality. From roots of *Grindelia robusta* on the cliff at Pacific Grove, Monterey County, Calif., Dec. 1, 1917.

Hosts and distribution. Known only as above.

Notes: This species is extremely close to *Trinoymus trifolii* (Forbes), of which I have had the privilege of examining a cotype specimen, received through the kindness of Mr. Forbes, and other specimens from Missouri, received from Mr. Hollinger. In fact these two are so very similar that it is only with much hesitation that I conclude to regard my species as distinct. The only difference of any importance lies in the fact that the dorsal body setae of *T. trifolii* are very small and slender, while in *T. grindeliae* they tend to be much larger and stouter. Further collecting may show the two to intergrade.

This is not the place to discuss at length a species not coming definitely within the limits prescribed for this paper, but I may note that the species *Trionymus trifolii* (Forbes) has been consistently misunderstood. Another species, in all probability *Pseudococcus maritimus* (Ehrh.), has been described as the "summer form" of *trifolii*, and, so far as I can determine, all the published records since the original description refer, at least in part, to this.

Trionymus smithii (Essig).

Plate 3, fig. 27.

1910. *Ripersia smithii* Essig, Pomona Col. Jn. Ent. **2**:218-220. (In part.)
1916. *Pseudococcus smithii* (Essig); Cockerell, Jn. Econ. Ent. **9**:312. (In part.)

In life. Concealed beneath the sheathing bases of the leaves of the host. Slightly covered with secretion, without lateral or caudal tassels.

Morphological characteristics. Antennae 7-segmented in adult female. But one pair of cerarii present, these on the anal lobes and consisting of but two small conical spines not accompanied by grouped pores

or slender setae. Dorsum with relatively few triangular pores and cylindrical ducts and very few multilocular pores. Last two segments of the abdomen with many short, slender, curved hairs both dorsally and ventrally, the remainder of the body with few. Anal ring rather small, the anal ring hairs quite short, the anal lobe hairs somewhat longer.

Immature female differing from the adult in having the antennae 6-segmented and in having the cerarian spines more or less setiform.

Type host and locality. From *Elymus condensatus,* Santa Paula, Ventura County, Calif.

Hosts and distribution. I have specimens of this from an unknown grass, Santa Clara Valley, Ventura County; from *Elymus* sp. at Alum Rock Park, San Jose; from undetermined grass growing in the chaparral on Jasper Ridge near Stanford University.

Authentication. Cotypes examined.

Notes: This is one of two species included by Essig under his *Ripersia smithii.* The other having been later described as *Trionymus californicus* Ehrh., the name *smithii* must be retained for the specimens herein described.

Trionymus villosa (Ehrh.).

Plate 3, fig. 31.

1899. *Riprsia villosa* Ehrhorn, Can. Ent. **31**:6.

In life. "Female in clusters and single in the crotches of twigs of oak. Sac loosely woven of long white wool, oval, about 2 mm. long and 1 mm. broad. Female when removed from the sac, bright crimson. . . ." (Ehrhorn). The specimens here described were in all probability not fully mature as the species reaches a much larger size.

Morphological characteristics. Antennae of adult female 7-segmented. Cerarii present only on the anal lobes, the cerarian spines small and slender but conical, accompanied by four or five small setae and with no grouped pores. On the two or three segments preceding the last three there is, at each margin, a single spine somewhat larger and stouter than those of the dorsum, these perhaps representing the vestiges of the cerarii of these segments. In the immature females these spines are quite prominent, but they are somewhat difficult to distinguish in the adult. Dorsal body setae few, scattered, quite small and slender. Derm with many triangular pores and also with numerous short, stout cylindrical ducts with a narrow raised rim about the mouth. Dorsum without multilocular pores. Anal ring hairs quite small, scarcely exceeding one-half the length of the anal lobe hairs.

Immature female not seen.

Type host and locality. From *Quercus agrifolia* at Berkeley, Calif.

Hosts and distribution. Known only from the above host. In the Essig collection from Claremont and Berkeley; in the Stanford collection from Mountain View, Santa Clara County, (Ehrhorn coll. and det.).

Authentication. Topotype and metatype specimens examined.

Notes: This is the species first described by Essig as *Pseudococcus agrifoliae.* For a discussion of the nomenclatorial problem involved see the notes under *Pseudococcus quercicolus.*

Genus **RIPERSIELLA** Tinsley.

Pseudococcine forms with the antennae set very close together at the front of the head, 5- or 6-segmented.

Type of the genus *Ripersia rumicis* Maskell.

Of this genus but one species is found in California. The material of this species examined by me is not of such a character as to permit any further explanation of the genus.

Ripersiella kelloggi Ehrh. & Ckll.

Plate 3, fig. 29.

1901. *Ripersiella kelloggi* Ehrh. & Ckll., Proc. Biol. Soc. Wash. **14**:166.

In life. "Adult female generally attached to the roots of grass, producing a small quantity of white, cottony secretion which generally encases the body. Color creamy white, about 1½ mm. long and 1 mm. wide, oval, sometimes pyriform, shiny." (Ehrhorn.)

Morphological characteristics. Antennae very small and short, set little more than the width of the basal segment apart, 5-segmented, the fifth segment nearly as long as the other four together. Legs very small and stout. Anal ring small, with short hairs.

Type host and locality. From roots of "bunch grass," Stevens Creek, Santa Clara County, Calif.

Hosts and distribution. Known only as above.

Authentication. Cotype slide examined.

Notes: I have not been able to find this species and know it only from a cotype slide sent me by Mr. Ehrhorn. Unfortunately a close study of the species is not possible without more material and I can say nothing in regard to the finer details of its morphology. Whether or not it is really congeneric with the type of this genus and with the other species included with it remains to be demonstrated.

Genus **CRYPTORIPERSIA** Ckll.

1899. *Ripersia* (*Cryptoripersia*) Cockerell, Can. Ent. **31**:5.
1899. *Cryptoripersia* Ckll., Ibid. **31**:278.

In defining *Cryptoripersia* as a subgenus of *Ripersia* Cockerell states

that it "will be distinguished by the possession of a complete subpyriform brittle sac." This is a bit optimistic, but the description of the genotype, *C. arizonensis* (Ehrh.) indicates that this species is very similar to the species later described by Ehrhorn as *Eriococcus salinus*. It must be admitted that this is only a surmise, but the latter species is certainly not an *Eriococcus* and does seem to resemble *C. arizonensis*. There being no other group into which it will fit, I regard it for the present as a *Cryptoripersia* and base the following characterization of the genus upon it.

Pseudococcine forms with but the anal pair of cerarii present, the cerarian spines in these being long and slender, their homology with the usual short conical spines being indicated only by their position and paired character. Anal opening on the dorsum at some distance from the posterior margin of the body. Antennae of the adult female and of first stage larva, 6-segmented.

Cryptoripersia salinus (Ehrh.).

Plate 3, fig. 30.

1911. *Eriococcus salinus* Ehrhorn, Can. Ent. **43**:276.

In life. Occurring on the roots of the host. The adult female entirely enclosed in a white, pyriform sac as much as 5 mm. in length. Oviparous.

Morphological characteristics. Adult female as much as 5 mm. long on the slide, pyriform or ovoid when flattened out, the anterior end pointed. Antennae 6-segmented, quite small. Anal cerarii only present, each with two slender hairs, no pores or auxiliary setae. Dorsal body setae few, appearing only on the head and posterior end of the abdomen, very small. Tubular ducts all very small, few in number. Dorsum of the abdomen without multilocular pores. Anal ring quite small, heavily chitinized, the anal ring setae slightly shorter than the anal lobe setae. In all my specimens the body flattens out on the slide in such a manner that the anal ring appears to lie on the dorsum at some distance from the posterior end of the body.

Immature female not seen. First stage larvae with 6-segmented antennae.

Type host and locality. From roots of "bunch grass," Alameda shore, Alameda, Calif.

Hosts and distribution. I have taken this species from the roots of a grass (*Stipa* sp. or *Poa* sp.) growing in bunches on the dry hillside in Stevens Creek Canyon, Santa Clara County, and from what is possibly the

same grass growing in the chaparral on Jasper Ridge near Stanford University.

Authentication. Cotype examined.

Notes: This species might very readily be confused with an apparently undescribed species (belonging to an unnamed genus) which I have taken from the roots of grass at Pacific Grove. The unnamed species, however, does not belong to this group and can readily be distinguished by the absence of triangular pores, the non-Pseudococcine ducts and the absence of dorsal ostioles.

Genus **ERIUM** Maskell.

Pseudococcine forms with cerarii on the anal lobes only, without marginal paired spines of any character. Dorsum beset with stout, spear-head-shaped spines, especially on the abdomen, without multilocular pores. Antennae of the adult female 7-segmented. Legs short and stout. Body more or less globular. Derm of the adult female blue-green. Adult female partially or entirely enclosed in a felted sac.

Type of the genus, *Erium globosum* (Maskell).

Notes: I have before me specimens of the type species from Australia, determined by Froggat, and this is certainly congeneric with our *E. lichtensioides.* In fact the two species are so much alike it is even difficult to separate them specifically. The genus has usually been based upon the fact that the adult female is entirely enclosed in a waxy sac, but this character is misleading. One species, *Pseudococcus eriogoni* (Ehrh.), which has been referred to *Erium* on this basis, certainly has nothing to do with it and possibly some of the others have also been wrongly placed. On the other hand, some species now referred to *Pseudococcus* appear to belong to *Erium,* among these being *P. ledi* Ckll. and *P. hymenocleae* (Ckll.). It is possible that *Pseudococcus ephedrae* (Coq.) likewise belongs here.

Erium lichtensioides (Ckll.).

Plate 3, fig. 25.

1891. *Dactylopius lichtensioides* Cockerell, Science Gossip, n. d., **3**:199.
1901. *Eriococcus artemisiae* Kuwana, Proc. Calif. Acad. Sci., (3), **3**:399, figs.
1902. *Erium lichtensioides* (Ckll.); Cockerell, Ann. Mag. Nat. Hist., (7), **10**:466.
1906. *Eriococcus artemisiae* var. *catalinae* Ehrhorn, Can. Ent. **38**:332.
1910. *Pseudococcus artemisiae* Essig, Pomona Col. Jn. Ent. **1**:42.
1914. *Pseudococcus hymenocleae* (Ckll.); Essig, Mon. Bull. Calif. State Com. Hort. **3**:118. (Misidentification?)

In life. In the earlier stages more or less covered with white secretion, later becoming entirely enclosed in a tough felted white sac which frequently is open along the dorsum. Insect black.

Morphological characteristics. Antennae 7-segmented, quite short. Derm of a blue-green color before staining. Cerarii present only on the anal lobes, containing as many as 10 "spear-head-shaped" spines, a few

pores and no auxiliary setae. Area about the cerarii more or less definitely chitinized. Dorsum of the abdomen and the posterior portion of the thorax with numerous spines of the same type as those in the cerarii. Toward the head these give way to short, slender setae. Derm, especially on the abdomen, with innumerable tubular ducts without a raised rim about their mouths. Legs quite short and stout, the posterior coxae with many ventral pores. Body form more or less globular.

Immature specimens resembling the adult except for a reduction in the number of spines in the cerarii. Male larva of the same type as in Pseudococcus.

Type host and locality. From *Artemisia frigida,* Fort Collins, Colorado.

Hosts and distribution. In California this species has been recorded from the vicinity of Stanford University and from the southern part of the state, the only recorded host being *Artemisia californica.*

Authentication. I have examined the types of this in the National Collection at Washington.

Notes: I am entirely in accord with Sasscer's conclusion that *Eriococcus artemisiae* Kuwana is identical with *Erium lichtensioides.* The types of the former species are in the Stanford collection. I have not seen the types of *Eriococcus artemisiae* var. *catalinae* Ehrhorn, but I can see no grounds for recognizing this variety. The types of *Pseudococcus artemisiae* Essig are unmistakably *E. lichtensioides,* but the figure accompanying the original description appears to be of another species occurring on *Artemisia.* I have this species, but do not possess enough material to justify naming it. The published record of the occurrence of *Pseudococcus hymenocleae* on *Artemisia* in California is probably based on a misidentification, as this species very much resembles *E. lichtensioides.*

Genus **ANTONINA** Signoret.

Pseudococcine forms without legs in the adult female; with the antennae in adult female reduced to mere stubs; without recognizable cerarii; with the posterior end of the body more or less invaginated, this invagination forming a tube at the inner end of which is the anal ring. Spiracles very large and conspicuous. Circular, multilocular pores present on the dorsum.

Type of the genus *Antonina purpurea* Sign.

Notes: Although the species of this genus depart widely in form and appearance from the general type of the group, there is, I believe, no doubt that its affinities are with the Pseudococcine forms. The cerarii are not recognizable, but the tubular ducts are of the same type as in *Pseudococcus* and there are two pairs of dorsal ostioles, although it is sometimes difficult to distinguish the anterior pair.

But one species of this genus has been recorded from California, although there are in all probability other species on our native grasses.

Antonina crawii Ckll.

Plate 3, figs. 23, 24.

1900. *Antonia crawii* Cockerell, Psyche 9:70.
1902. *Antonina crawii* Ckll.; Kuwana, Proc. Calif. Acad. Sci., (3), 3:57, fig.
1915. *Antonina crawii* Ckll.; Essig, Inj. & Benef. Ins. Calif., 2d ed., 132-3.

In life. "The full grown female scales are covered with a thick, compact white cottony coat which makes them very conspicuous. The body proper varies from 1/8 inch to nearly 1/4 inch long, is broadly oval or rounded and deep purplish-red in color. The females collect in colonies, forming large cottony masses in the leaf axils of the canes." (Essig.) From the posterior end of the body there usually arises a conspicuous white, waxen thread.

Morphological characteristics. General form elongate, tapering somewhat posteriorly. The adult female is apodous and the antennae are reduced to mere conical stubs with three segments. Last two segments of the abdomen quite heavily chitinized and bearing numerous short, spike-like spines, the remaining segments with just a few very small spines at the margins. Entire body with numerous small cylindrical ducts. A longitudinal area of circular pores at the lateral margins.

Immature stages. I have seen only the first stage larva. In this the antennae are of the usual type, 6-segmented. At the lateral margin of each of the last three abdominal segments is a group of two or three stout spines which may be the homologues of the cerarii. The anal ring is very heavily chitinized and bears six short, stout, spine-like setae.

Hosts and distribution. An introduced species found on bamboo, in various parts of California. I have examined species from Ventura received from E. O. Essig.

Notes: It is by no means certain that this is really *A. crawii* Ckll. The California specimens agree with certain specimens taken at Yokohama, Japan, by Kuwana and identified by him as this species. They do not agree with other specimens from Tokyo, Japan, likewise identified as this species by Kuwana. In the latter lot the antennae are 2-segmented and the spines on the posterior end of the abdomen are much longer and more slender.

This differs from *A. indica* Green, of which I have specimens from Bermuda grass in Hawaii (det. Ehrhorn), in the much more elongate form and the much shorter and stouter abdominal spines. It appears to differ in this latter character from *A. nortoni* Parrott & Ckll. and *A. gramnis* Parrott.

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PLATES
WITH EXPLANATIONS

PLATE I.

1. *Pseudococcus crawii* (Coq.); penultimate and anal lobe cerarii.
2. *Pseudococcus comstocki* (Kuw.); penultimate and anal lobe cerarii (left) and ventral side of anal lobe (right).
3. *Pseudococcus sequoiae* (Coleman); penultimate and anal lobe cerarii.
4. *Pseudococcus longispinus* (Targ.); penultimate and anal lobe cerarii (left) and ventral side of anal lobe (right).
5. *Pseudococcus salinus* (Ckll.); posterior end of abdomen. Penultimate and anal lobe cerarii (left) and ventral side with half of anal ring (right).
6. *Pseudococcus citrophilus* Claussen; penultimate and anal lobe cerarii (left) and ventral side of anal lobe (right).
7. *Pseudococcus citri* (Risso); penultimate and anal lobe cerarii (left) and ventral side of anal lobe (right). Except for the shape of the spines this figure will apply for *P. kraunhiae* (Kuwana).
8. *Pseudococcus kraunhiae* (Kuwana); cerarian spine (above) and dorsal body seta (below).
9. *Pseudococcus citri* (Risso); cerarian spine (above) and dorsal body seta (below).
10. *Pseudococcus longisetosus* n. sp.; penultimate and anal lobe cerarii (left) and ventral side of anal lobe (right).
11. *Pseudococcus cupressicolus* n. sp.; penultimate and anal lobe cerarii. Except for the very slightest details this figure will apply equally well for *Pseudococcus ryani* (Coq.).

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PLATE II.

12. *Pseudococcus nipae* (Maskell); penultimate and anal lobe cerarii (left) and ventral side of anal lobe (right).

13. *Pseudococcus maritimus* (Ehrh.); penultimate and anal lobe cerarii (left) and ventral side of anal lobe (right).

14. *Phenacoccus eriogoni* n. sp.; penultimate and anal lobe cerarii.

15. *Phenacoccus artemisiae* Ehrh.; penultimate and anal lobe cerarii (left) and ventral side of anal lobe (right).

16. *Phenacoccus artemisiae* Ehrh.; cephalic margin of the body of immature specimen.

17. *Phenacoccus stachyos* Ehrh.; penultimate and anal lobe cerarii (left) and ventral side of anal lobe (right).

18. *Pseudococcus quercicolus* n. sp.; penultimate and anal lobe cerarii.

19. *Pseudococcus timberlakei* Ckll.; penultimate and anal lobe cerarii (left) and ventral side of anal lobe (right). Except for the ventral side of the anal lobe this figure will apply equally well for *Trionymus californicus* Ehrh.

20. *Phenacoccus colemani* Ehrh.; a, penultimate and anal lobe cerarii (left) and ventral side of anal lobe (right) of the typical form; b, anal lobe cerarius of an extreme form.

21. *Phenacoccus solani* n. sp.; penultimate and anal lobe cerarii; a, disproportionately enlarged dorsal body seta.

22. *Phenacoccus stachyos* Ehrh.; various modifications of the ducts.

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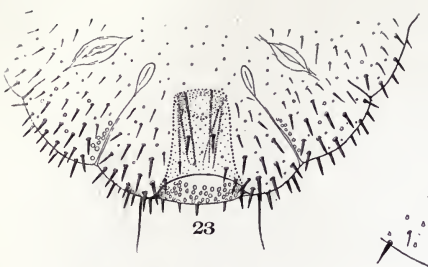
PLATE III.

23. *Antonina crawii* Ckll.; dorsal aspect of posterior portion of abdomen of adult female.
24. *Antonina crawii;* dorsal aspect of posterior portion of abdomen of first stage larva.
25. *Erium lichtensioides* (Ckll.); anal lobe cerarius.
26. *Trionymus grindeliae* n. sp.; anal lobe cerarius.
27. *Trionymus smithii* (Essig); anal lobe cerarius and half of anal ring.
28. *Trionymus distichlii* n. sp.; anal lobe cerarius and anal ring.
29. *Ripersiella kelloggi* Ehrh.; antenna of adult female.
30. *Cryptoripersia salinus* (Ehrh.); dorsal aspect of posterior end of abdomen.
31. *Trionymus villosa* (Ehrh.); anal lobe cerarius and anal ring.
32. *Heterococcus arenae* n. sp.; penultimate and anal lobe cerarii and half of anal ring.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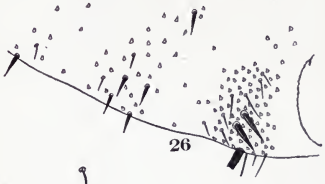
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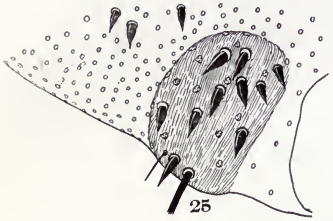
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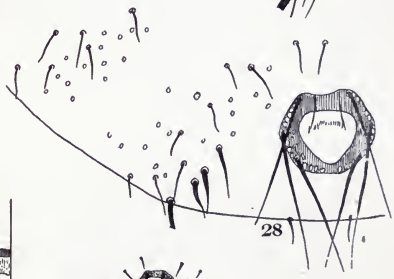
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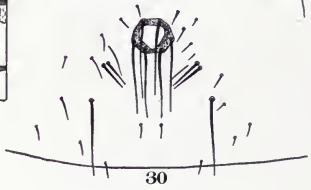
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